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Dr. LEE, President, in the Chair.

Lieut. Bailey, R.N., H.M.S. Excellent;
Lieut. H. Morland, Ebury Street, Pimlico; and
David Hornby, Esq., 46 Guildford Street,

were balloted for and duly elected Fellows of the Society.

Letter from Prof. Grant to the Editor.

I send you herewith, for insertion in the *Monthly Notices*, a communication which I have received from Prof. Smyth, containing a description of the great equatoreally mounted Refractor, of 11 inches aperture, erected a few years since by J. W. Grant, Esq., of Elchies, Morayshire; also some results of observations made by Prof. Smyth with the same instrument, on the occasion of a visit which he recently paid to Mr. Grant. It may be mentioned that the owner of this magnificent instrument resided many years in India, during which he employed much of the leisure time of an official life in cultivating scientific studies of various kinds, occupying himself occasionally with a 5-foot refractor of excellent quality. As an instance of what an observant eye may effect under favourable circumstances of climate, even although aided by an instrument of only inferior power, it may be stated that the duplicity of *Antares* was recognised by Mr. Grant as early as the 23d of July, 1844, that is to say, *two years anterior* to the discovery of the same interesting fact by the American astronomer, Prof. Mitchell, with the aid of the great Cincinnati Refractor (*Monthly Notices*, vol. xvi. p. 56). Prof. Smyth was recently led to a knowledge of this circumstance by an exami-

nation of Mr. Grant's observation papers. That it was not communicated earlier to the world is accounted for by Mr. Grant's retiring disposition, and by the modest estimation which he has invariably formed of his scientific labours. Prof. Smyth purposes communicating to the Society, on an early occasion, an account of Mr. Grant's astronomical observations in India.

Upon his return to Scotland, about twelve years ago, with the intention of spending the remainder of his life on his patrimonial estate, Mr. Grant resolved to continue his astronomical observations; and with a view to this object, he erected at Elchies* a substantial Observatory, which he fitted up with the great Equatoreal of 11 inches aperture, to which I have already referred. This was the first equatoreally mounted Refractor of considerable magnitude which had hitherto been erected in Scotland: indeed, with the exception of the Equatoreal of nine inches aperture subsequently acquired by the late Sir William Keith Murray, it is the only instrument of the kind deserving of the name which has ever been mounted in the northern part of this island. The unsuitableness of the climate of Elchies for astronomical observations, and recently continued ill-health, have prevented Mr. Grant from availing himself so fully of the advantages of this noble instrument as his Indian experience entitled him to hope for, and as the munificent sacrifice made by him in the cause of science so well merited.

At Prof. Smyth's request I have appended one or two footnotes to his communication, as, from the circumstance of his present temporary residence in the country, his access to original authorities has been necessarily limited.

Observatory, Glasgow, October 13th, 1862.

Experiences with the Elchies Equatoreally mounted Refractor of 11 inches aperture, in September 1862. By Prof. C. Piazzi Smyth, Astronomer Royal for Scotland.

Description of the Instrument.

This is a very remarkable instrument, as well in its mechanical as its optical portions, and I have had an unusual opportunity of becoming practically acquainted with both, during a continued stay of three weeks; for the whole of which time the key of the Observatory, and complete control over,

* Prof. Grant informs me that Elchies is situate about eight miles below the junction of the Spey and the Avon.—Ed.

and employment of, everything therein, were kindly conceded to me by the owner, and with the frequently repeated instructions that I was to employ them as freely as if the entire Observatory had been my own property.

From long remaining unused, a good deal of dust and thickened oil had to be removed before beginning work; but, that once done, all the essentials of the instrument were found in excellent condition, and micrometer observations of double stars were from that time made every fine night, and with a great feeling of satisfaction in the use and working of the instrument.

Optical Parts.

The object-glass is 11 inches in diameter and 16 feet in focal length. It has a number of minute bubbles in it (as indeed almost every object-glass has, and without further detriment than merely the loss of as much light as they intercept); but I have not been able to see any trace of striæ or positive imperfections in the glass, either by looking at or through it; or, by examining the discs of stellar light, by viewing a bright star, *α Lyræ*, much out of focus, and with a magnifying power of 397.

This power has been employed in all the observations, and with it, notwithstanding the very untoward state of the weather, some excellent proofs have been obtained of both the light-transmitting and the defining powers of the object-glass; though it is believed that better proofs still might be obtained, if a fully good night were to occur, and more difficult test objects to be above the horizon. The results, however, as far as yet secured, may be stated thus:—

In the course of examining a list of twenty-five well-known double stars, there were six cases where one or more additional small stars, not previously known or recorded, were discovered; besides two or three cases where small stars, whose existence had merely been mentioned by other observers, were found bright enough to admit of micrometer measurement in the Elchies telescope, with a position and distance wire micrometer and lamp-illuminated field.

These instances, of which a special list will be appended, and which speak chiefly for the light-transmitting power of the object-glass, were attained, even in spite of such bad definition of the atmosphere, that every star was more or less blurred and nebulous. There have indeed been only two occasions, and then only for a few minutes each time, when the atmosphere quieted and allowed the defining power of the object-glass itself to be studied; the first of these instances was on Sept. 17th, at 1^h P.M., when the Pole star was in the field, and looked a minute and brilliant disk with well-shaped thin rings around it, in the bright sunshine; the second was on Sept. 20th, at

$5^h\ 30^m$ A.M., when B of γ *Andromedæ* was distinctly seen as two different and completely separated stars, which were measured accordingly both in position and distance. While that it was a triumph to the object-glass to see them in that manner, I may mention that the disk of each star was considerably less than the diameter of the fine spider's thread of the micrometer, and about 0·3, or 0·4 of a second of space in diameter; the distance apart, from centre to centre, being about 0·6 of a second.

In completion of the optical details it may be mentioned, that there are twenty-three eye-pieces of various powers, in addition to the two of the micrometer; twenty-four caps with coloured glass, several piles of coloured glass disks, screwing into each other, a fine totally reflecting prism of very large size, a dynameter, &c., in two mahogany cases; besides the position wire micrometer in its own box. The telescope has three finders, one of them being a fine 5-foot telescope, and is furnished with an illuminating apparatus for use with the micrometer.

Mechanical Parts.

The Equatoreal Motion.

The mounting of the Elchies telescope is on the principle known as the German, in contradistinction to the English, or the form with a long polar axis, and the telescope in the middle between the bearings.

The German form, viz., with short polar axis and telescope outside both bearings, is perhaps more frequently employed in every country than the other, and specimens of it in connexion with large telescopes are now numerous; but nowhere over the whole world has so firm, and solid, and well-constructed an example ever been mounted as that of Elchies.

This is saying a great deal, especially in knowledge of the admirable models sent forth to various public and private Observatories by the astronomical factories of Munich, Paris, and York; but I believe it to be perfectly true, and owing, greatly, to the late Mr. A. Ross, the optician of the telescope, having secured the services of Messrs. Ransome and May, Engineers, Ipswich, for the mounting. Messrs. Ransome and May were the firm who had been already selected and employed by the Astronomer Royal, to introduce into the new Greenwich instruments the solidity and improved methods of modern engineering; and I know that they entered with great zeal into the efficient carrying out of Mr. Ross's order, Mr. May himself personally assuring me, that he believed this instrument would be the beginning of a new era in the construction of Equatoreals, by reason of the astonishing firmness and steadiness, combined with truth, which he expected the mass of metal introduced into this one, and duly turned and planed, would impart to its

movements. It was this mounting, accordingly, which attracted such general attention and commendation in the centre of the nave of the British portion of the International Exhibition in 1851, and it commends itself equally now, after eleven years standing in an Observatory.

The declination and polar axes, each about 6 inches in diameter, in solid metal, and 5 feet long, are wonders of strength in connexion with any optical instrument, and could never have been produced by any mere optician; while the gun-metal bearings, and gun-metal circles, together with the gearing and ungearing apparatus for the endless screws, is of a majesty of form, size, and substance, more like steam-engine, than ordinary telescope, fittings.

Both circles, 30 inches in diameter, are cast as disks of gun metal, without any perforations, about 1 inch thick, additionally strengthened towards the centreing, and furnished with rack edge and noble endless screws to work in them, of actually 2·1 inches in diameter; while their end-shake and wear in their bearings is corrected by the efficient method adopted in the shaft of a screw steamer; or, by having a long series of projecting flanges cut on the pivot, and working into a similar series of depressions in the gun-metal bearing.

It will thus be seen that this part of the entire instrument is quite worthy both of the engineering fame of Messrs. Ransome and May, and of their training for astronomical structures under George Biddell Airy; and to their work Mr. Ross has added various fine fittings, graduation on the circles very easily read, an excellent system of double Hooke's-joint handles, workable from the eye-piece of the telescope, and an efficient equatoreal driving clock.

The Stand.

The mere stand or pier for supporting the bearings of the above-mentioned equatoreal axes of motion, is also a noteworthy point about the Elchies instrument. It is of iron, and by Messrs. Ransome and May also; there are the usual adjustments for the bearings of the axes, and the general form is convenient; but the remarkable and unprecedented thing is the extraordinary amount of weight introduced into it, for the purpose of checking those minute tremors which usually disturb accurate vision in all of the ordinary forms of mountings of large telescopes; and which can only be thoroughly corrected by the absorbing effect of mass. One portion of the stand accordingly weighs no less than eleven tons, and is the greatest quantity of iron ever cast into a single piece for any astronomical instrument of any age or in any country.

In conclusion I have to add, that though the telescope be so large, and the mounting so heavy, and though I have never had experience in the use of so large a telescope before, yet I found

no difficulty in managing this one without any assistance, could point from star to star by their places on the circles, with as much rapidity as on many much smaller instruments; could bisect the stars on the micrometer wires so well, by merely using the Hooke's-joint handles from the circle-screws, as to dispense with a "slipping piece" for the micrometer; and, finally, have never yet seen the smallest trace of instrumental tremor.

Sept. 27, 1862.

Appendix of Results of Observations with the Elchies Telescope in 1862.

28 Aquilæ, Mean R.A. $19^h\ 13^m\ 14^s$, and Decl. $+\ 12°\ 7'\ 22''$, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.		Full Weight.	Distance.	Full Weight.
			°	′		″	
A	6·2	Yellowish			= 10·0		= 10·0
B	10·0	Purplish	A B	176 38	(w. 1·0)	60·44	(w. 0·6)
(New) C	17·0	Blueish	A C	102 25	(w. 0·4)	66·76	(w. 0·1)

Date of observation = 1862·72.

The magnitudes and colours in Admiral Smyth's "Cycle" for A and B are "6 and 10, and pale white and deep blue," and are not more different from the above than atmospheric effects might explain, especially as the Elchies Observations were taken during twilight and the influence of its warm colouring. For the position and distance of A and B, previous measures are not abundant; but, numerically, both the angles of position and the distances are consistent in indicating some physical changes. Thus,

	Position.		Distance.	Date.
	°	′	″	
S.	175	4	59·28	1825·04
Sm.	175	42 (w. 8)	59·8 (w. 5)	1831·42 *

The new star therefore, C, picked up by the superior

* This star is not, of course, inserted in Struve's great Catalogue, the distance of the components exceeding his prescribed limits; but it is included in a list (given in the *Mensuræ Micrometricæ*, pp. 317, 318) of objects measured with a small instrument in the years 1821–23. The results are,

Dist. 60″·01 Pos. angle 176°·9 Epoch 1822·19.—R. G.

optical power of Mr. Grant's telescope, may become an important member in the system for future observers.

δ Aquilæ, R.A. $19^h\ 18^m\ 31^s$, and Decl. $+ 2°\ 50'\ 25''$, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Full Weight.	Distance.	Full Weight.
			° ′		″	
A	3·5	Faint yellow		= 10·0		= 10·0
B	16·0	Blueish	A B 275 35	(w. 0·3)	94·96	(w. 0·2)
C	14·0	Blueish	A C 114 15	(w. 0·3)	192·30	(w. 0·1)

Date of observation = 1862·74.

B was invisible to the Sheepshanks' 5-foot at Guajara, Teneriffe, in 1856; but C was just visible, and, in the total absence of B, and without any micrometrical measures, led to a suspicion of a slip of 180° in the Tables. Now, however, the Elchies telescope, with its greater space-penetrating power, shows B still existing nearly as detailed in the "Cycle," but reduced from the 12th mag. in 1833·62 to the 16th in 1862·74; and if it was of that small size in 1856, no wonder that the small Sheepshanks' telescope was unable to show it.

The changes from the "Cycle" position and distance, 259° 3′ (w. 1) and 96″·5 (w. 1) in 1833·62 are probably effects of proper motion, and for the most part of A; if so, and if B and C, which are on either side of A, be greatly more distant, as indeed their small magnitudes imply, it will be of the utmost importance that A should in future be measured from both of them, instead of from B alone.

128 Anseris, R.A. $19^h\ 20^m\ 26^s$, Decl. $+ 19°\ 37'\ 12''$, Jan. 1, 1862.

Components.	Mags.	Colour.	Position.		Distance.	
			″ ′		″	
A	6·5	Orange				
B	13·0	Violet	A B 41 2	(w. 1·0)	22·53	(w. 0·3)
C	12·0	Blue	A C 319 55	(w. 1·0)	68·14	(w. 0·2)

Date of observation = 1862·71.

The existence of the star C was discovered with the Sheepshanks' 5-foot telescope, at Guajara, in Teneriffe, and would appear now to be an important point to observe in future in connexion with A and B; for the above measures, compared with

	Position.	Distance.	Date.
	° ′	″	
Σ	43 35	22·647	1829·40
and Sm.	44 48 (w. 3)	25·0 (w. 1)	1833·58

indicate an orbital movement not hitherto recognised.

The Sm. observation is indeed somewhat anomalous, but it

was taken with an unusual micrometer, and, because "illumination was precluded to so small an object as B," appeared in the Bedford telescope. In Mr. Grant's larger telescope, however, B was comparatively so bright that there was no difficulty in illuminating the field and employing the usual wire-micrometer.

β Cygni, R.A. $19^h\,25^m\,9^s$, Decl. + 27° 40′ 20″, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	3	Yellow		
B	7	Blueish-green	A B 55 28 (w. 2·0)	34·20 (w. 1·0)
(New) C	15·3	Blue	A C 340 2 (w. 1·0)	61·49 (w. 0·5)
(New) D	15	Blue	A D 33 45 (w. 0·5)	107·50 (w. 0·2)

Date of observation = 1862·72.

The above magnitudes and colours of A and B coincide closely with those in the "Cycle," or, "3 and 7, and topaz yellow and sapphire blue." The positions and distances show a slight discordance from the authorities quoted or given there; as thus:—

	Position.	Distance.	Date.
	° ′	″	
B	57 34	34·20	1755·00
$\frac{H}{O}$	54 52	34·83	1782·45
P	54 31	34·28	1800·00
Σ	54 30	34·29	1821·76
H and S	54 45	34·38	1822·98
D	55 32	34·51	1830·54
Sm.	55 24 (w. 5)	34·2 (w. 5)	1830·81
Sm.	55 36 (w. 9)	34·4 (w. 9)	1837·58

Perhaps the two new stars may assist in proving whether, as has been supposed, both A and B are affected by proper motion, and either one differently.

ζ Sagittæ, R.A. $19^h\,42^m\,52^s$, and Decl. + 18° 47′ 47″, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	5·2	Whitish		
B	9·7	Violet	A B 313 19 (w. 1·0)	8·58 (w. 1·0)
(New) C	15·0	Blue	A C 250 42 (w. 1·0)	70·73 (w. 0·5)

Date of observation = 1862·73.

The above magnitudes and colours again come near those of the "Cycle;" and the positions and distances confirm them

remarkably in a feature where they had differed materially from older authorities, the series running thus :—

	Position.	Distance.	Date.
	° ′	″	
$\frac{H}{O}$	304 10	8·83	1781·88
Σ	309 30	8·77	1819·74
H and S	314 32	8·82	1823·69
H	318 26	9·81	1829·63
Sm.	313 24 (w. 7)	8·9 (w. 7)	1831·59
Sm.	312 18 (w. 9)	8·6 (w. 9)	1838·67

The reason of these differences, so much larger than ordinary errors of observation, is difficult to conjecture truly, and may imply a dark planet of large size accompanying one of the stars. The new star C, now shown to exist, is too far off in itself to explain such perturbations, but may prove a useful referring point for the future.

452 Cygni, R.A. $20^h\ 57^m\ 4^s$, and Decl. + 38° 58′ 0″, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	6	Reddish orange		
B	10	Greenish	A B 300 33 (w. 2·0)	19·22 (w. 0·5)
(New) C	13	Blueish	A C 86 53 (w. 1·0)	98·01 (w. 0·4)
D	15·5	Blueish	A D 138 54 (w. 1·0)	54·29 (w. 0·3)

Date of observation = 1862·73.

The stars A and B are here each one magnitude larger than in the "Cycle;" the colours are nearly the same; but the position and distance indicate rapid proper motion, being given as 297° 0′ (w. 3) and 17″·0 (w. 1) respectively, in 1832·87. Neither C nor D are measured there, but D is evidently alluded to as a star "of the 13th magnitude, *s f*, and sufficiently near to form with A and B a triple object:" a description which indicates a change of magnitude to have occurred since then.

1 Pegasi, R.A. $21^h\ 15^m\ 43^s$, and Decl. + 19° 12′ 56″, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	4·5	Yellowish		
B	9	Grey	A B 311 16 (w. 2·0)	36·76 (w. 0·5)
(New) C	14·5	Blue	A C 22 59 (w. 1·0)	80·03 (w. 0·3)

Date of observation = 1862·72.

The magnitudes and colours of A and B, as here detailed, are nearly conformable to those of the Cycle; while the angles

of position and distances accompanying raise their history from "indicating no notable change," in 1833, to exhibiting a regular, though slow, orbital movement in 1862; as thus:—

	Position.	Distance.	Date.
	° ′	″	
H	308 19	37·10	1780·69
S	310 11	36·86	1825·22
Sm.	310 48 (w. 8)	36·40 (w. 5)	1833·95

The new star C may or may not form a member of the system, of which the proper motion is so very large that there is much need for a heavenly milestone to measure its movements from.

312 Pegasi, R.A. $21^h\,45^m\,6^s$, and Decl. + 19° 10′ 53″, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	7	Yellowish		
B	15	Blueish	A B 92 28 (w. 1·0)	20·32 (w. 0·5)
(Rediscoverd) C	17	Blueish	A C 323 34 (w. 0·5)	21·74 (w. 0·3)
(New) D	15·5	Blueish	A D 193 48 (w. 0·4)	80·95 (w. 0·2)
(New) E	17	Blueish	A E 355 52 (w. 0·2)	127·30 (?)
(New) F	18	Blueish	A F 308 52 (w. 0·2)	106·10 (?)

Date of observation = 1862·74.

The stars A and B having been described as "in a barren field" when looked at with a good 6-inch object-glass, I turned the Elchies telescope to them, and immediately saw C also; but this star had been previously discovered by Sir John Herschel with his 20-foot reflecting telescope, as mentioned in the "Cycle." A little further attention, however, soon revealed the additional stars D, E, and F, which, as far as I yet know, are new.

The position and distance of A and B, given above, differ from those of the "Cycle" beyond the limits of error of observation, and merit attention therefore; the numbers being

Position.	Distance.	Date.
95°·0 (w. 1)	15″·0 (w. 1)	1838·66

Elchies new (?) R.A. $21^h\,47^m\,46^s$, and Decl. + 19° 2′ 53″ nearly, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	6·7	Yellow		
B	8·7	Lilac	A B 110 58 (w. 2·0)	22·26 (w. 1·0)

Date of observation = 1862·73.

This pair of stars was picked up accidentally, by its coming into the 5-foot finder of the Elchies grand telescope, when the star "312 *Pegasi*" had passed out, through the weights of the driving clock having run down. I have not yet met with any observations of this double star elsewhere; but my references at the present moment are limited, and it seems too bright and too conspicuous for contrasted colours to have escaped many previous observers.*

ψ′ Piscium, R.A. $0^h\ 58^m\ 17^s$, and Decl. + 20° 44′ 1″, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	5	Yellowish white		
B	5·5	Blueish white	A B 160 22 (w. 2·0)	30·17 (w. 2·0)
C	12·5	Blueish	A C 121 20 (w. 1·0)	97·33 (w. 1·0)

Date of observation = 1862·72.

The existence of C was noted in the "Cycle" as "a very small star following;" but it was not micrometrically observed.

The measures there recorded of A and B are considered "to show *fixity*:" but if the present determination can be trusted to within a very small quantity, an extremely slow orbital movement may rather be inferred; the whole of the previous measures standing thus:—

	Position.	Distance.	Date.
	° ′	″	
H	170 0	27·50	1779·83
H and S	161 2	30·34	1822·38
Sm.	160 24 (w. 8)	30·2 (w. 8)	1833·97

The mags. and colours, given in the "Cycle" as "both 5·5 mag., silvery white," indicate little relative change in these respects during the last twenty-eight years.

222 Arietis, R.A. $1^h\ 51^m\ 56^s$, and Decl. + 20° 23′ 14″, Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	0	0		
B	12	Blueish	A B (w. 1·0)	(w. 1·0)
C	12	Blueish	B C 169 15 (w. 0·5)	36·94 (w. 0·3)
D	7·5	Faint yellowish	B D 0 35 (w. 0·5)	180·44 (w. 0·3)

Date of observation = 1862·74.

The observation of this group gave me great trouble and

* This star appears to be identical with No. 2841 of Struve's great Catalogue (*Mensuræ Micrometricæ*, p. 188).—R. G.

perplexity, until at last, by successive trials, I became perfectly confident of freedom from clouds, and the absolute R.A. and D. in the field of the telescope, and then recognised that every member of the group was present, except its brightest and leading component; viz. A, which the "Cycle" puts down as of the 6th mag.; while B and C and D are entered of the 15th, 10th, and 9th respectively!

Since the year 1834, therefore, D has increased considerably, and B somewhat; while C has slightly decreased, and A gone out altogether, or at least so far as the great Elchies telescope can penetrate into space! Yet perhaps the most immediately important circumstance of the whole case for practical astronomers is, that it has been said of the group, "It forms an admirable test to try the light and distinctness of a telescope."

The "Cycle" positions and distances to compare with the above are,

	Position.	Distance.	Date.
	° ′	″	
A B	53 0 (w. 1)	2·5 (w. 1)	1834·99.
A C	165 0 (w. 2)	40·0 (w. 1)	
A D	359 12 (w. 2)	165·0 (w. 2)	

γ Andromedæ, R.A. $1^h\ 55^m\ 25^s$, and Decl. $+\ 41°\ 40'\ 3''$,
Jan. 1, 1862.

Components.	Mags.	Colours.	Position.	Distance.
			° ′	″
A	3·5	Orange yellow		
B	5·5	Blueish green	A B C 62 12 (w. 2·0)	9·73 (w. 0·3)
C	6·0	Blueish green	B C 116 23 (w. 1·0)	0·57 (w. 0·3)

Diameter of disk of B = 0·37
" " C = 0·23
" " wire = 0·58

Date of observation = 1862·71.

The above observations were procured in the early morning, about sunrise, on one of the only two occasions during the week when I had the fortune to witness, for a few minutes each time, a cessation of those atmospheric disturbances on which the definition of stars seen in a good telescope so greatly depends. The disks of the two close stars were then completely and more than separated, and were so small as to be in diameter only about half the apparent thickness of the fine spider's line of the micrometer employed in the measures.

Concluding Notes on the Observations.

The preceding observations have been hastily arranged, while on the road, so as to represent at one view the results, generally of two and sometimes of three nights' observation of each object. In affixing *weights* to the observations, while following my Father's method, as explained in his "Cycle," and keeping to his upper limit of 10, I have been obliged to descend below his lower limit of 1, by using tenths. This was because the atmospheric perturbations of telescopic definition on the banks of the Spey were really so fearful, and at almost every observation, that, had it not been my first, and too probably my last, opportunity of looking into the Elchies telescope, and therewith examining some anomalous features noted when gazing at certain double stars on the Peak of Teneriffe in 1856, and which I have had no other opportunity of inquiring into, I should not have made any observations at all, but have waited for a more favourable condition of the atmosphere.

By assigning such small weights as I have done, I hope to avoid doing any harm by otherwise sending out inferior, to mix, uncorrected, with superior observations by other and abler hands; while, with some of the objects, the cosmical changes have been so rapid, or the powers of the telescope so transcendent, as to overbear the rudeness of my micrometer-measures, and to show some valuable additions to the many physical facts recorded in the "Cycle" up to its closing epoch. That book is the only one I have yet compared the observations with, and the only one I have with me on the journey; but I trust that I shall be allowed more honourable reasons also, for desiring to use it as a standard work of reference.

The value of the micrometer-screw in seconds of space has as yet only been approximately determined from the observations made for the purpose, and may, perhaps, require a small addition, as of about $\frac{1}{200}$ of the whole; but that present uncertainty on the distances alone, will not at all interfere with the character of the chief results now brought out, as affecting the discovery of new stars and changes in angle of position of old stars, or large variation in their distances.

Illumination of the field, and by red light, according to Sir John Herschel's discriminating suggestion, was always employed for the actual micrometer-measures; but the estimation of magnitudes and colours was always made in a darkened field.

Oban, October 7th, 1862.

Extract of a Letter from Dr. Wolfers to the Rev. R. Main, dated Berlin, October 31, 1862.

The xxth volume of the *Radcliffe Observations*, presented to me by the Radcliffe Trustees, came into my hands some time ago, and I have compared the places of the fundamental stars contained in that volume with those contained in the *Tabulæ Reductionum*. In this manner I have formed the two tables, A and B, belonging respectively to the years 1859 and 1860. There are some differences between observation and calculation (F.—W.), which are too great to be attributed to errors of observation. It is possible that there is an error committed in the reduction of the observations, wherefore I have included in [the] differences in question. These being excepted, I have combined the two series of differences with the series obtained in the year 1861, and published in the *Monthly Notices*, vol. xxii. No. 2, p. 31. In this manner I have obtained the table designated by the letter C.

Excluding now the R.A. of the circumpolar stars α and γ *Ursæ Majoris*, α, β, and δ *Ursæ Minoris*, and of α *Geminorum* (the latter for a reason previously given), the result of the comparison is the following:—

Number of Observations.	F.—W. in R.A.	Number of Observations.	F.—W. in Decl.
	s		″
448	+0·110	307	+0·032

This result being compared with the result of the preceding year, viz.

Number of Observations.	F.—W. in R.A.	Number of Observations.	F.—W. in Decl.
	s		″
326	+0·017	288	+0·046

it is evident that, as the number of observations is increased, the mean difference of the two co-ordinates is diminished. These values belong to January 1, 1860.

A.

Right Ascensions and Declinations of Fundamental Stars observed at the Radcliffe Observatory in the Year 1859, compared with those contained in the Tabulæ Reductionum.

Name of Star.	Number of Observations.	F.—W. R.A.	Number of Observations.	F.—W. Decl.
		s		″
α Andromedæ	1	0·00		
γ Pegasi	3	−0·11		
α Arietis	1	−0·01		
α Ceti	1	+0·08		
α Geminorum			1	+2·0

Name of Star.	Number of Observations.	F. — W. R.A.	Number of Observations.	F. — W. Decl.
		s		″
α Canis Minoris	1	[+0·15]	1	−1·2
β Geminorum	1	−0·04		
α Hydræ	3	−0·02		
α Leonis	1	0·00		
β Leonis	1	+0·05		
α Virginis	3	0·00	1	−0·1
η Ursæ Majoris			1	−2·7
α Böotis	1	+0·01		
α Coronæ	1	−0·02		
α Serpentis	1	−0·04		
α Herculis	1	0·00		
α Ophiuchi	4	−0·02	1	−0·3
α^1 Capricorni	1	+0·07		
α Cygni	2	−0·04		
α Aquarii	5	−0·03	1	−0·3

B.

Right Ascensions and Declinations of Fundamental Stars, observed at the Radcliffe Observatory in the Year 1860, *compared with those contained in the Tabulæ Reductionum.*

Name of Star.	Number of Observations.	F. — W. R.A.	Number of Observations.	F. — W. Decl.
		s		″
α Andromedæ	2	[−0·13]		
γ Pegasi	3	[−0·20]		
α Arietis	5	−0·02	1	+2·8
α Ceti	4	−0·05		
α Tauri	1	[−0·27]		
β Leonis	1	+0·05		
β Virginis	2	+0·11		
γ Ursæ Majoris	1	[+0·41]		
η Ursæ Majoris	4	[+0·18]		
α Böotis	1	[−0·38]		
α^2 Libræ	1	+0·06		
β Ursæ Minoris			1	−2·2
α Serpentis	1	+0·11		
α Scorpii	1	[−0·28]		
α Herculis	2	−0·07		
α Ophiuchi	4	−0·04		
γ Draconis	4	+0·12		
α Lyræ	2	−0·03		
γ Aquilæ	9	−0·10	3	−0·6

Name of Star.	Number of Observations.	F.—W. R.A. s	Number of Observations.	F.—W. Decl. ″
α Aquilæ	9	−0·01		
β Aquilæ	11	+0·03	2	−2·0
α^2 Capricorni	2	+0·13		
α Cygni	14	−0·07		
α Cephei	5	[+0·37]	1	+0·7
β Cephei			4	[−4·6]
α Aquarii	9	−0·06		
α Piscis Austrini	1	−0·01		
α Pegasi	10	+0·02	1	−2·0
α Ursæ Minoris	6	−0·15	3	+0·8
δ Ursæ Minoris			1	+1·5

C.

Right Ascensions and Declinations of Fundamental Stars observed at the Radcliffe Observatory in the Year 1861, *compared with those contained in the Tabulæ Reductionum.*

Name of Star.	Number of Observations.	F.—W. R.A. s	Number of Observations.	F —W. Decl. ″
α Andromedæ	5	+0·02	5	+0·7
γ Pegasi	12	−0·06	6	+2·6
α Cassiopeiæ	3	+0·09	4	−0·4
α Arietis	12	−0·02	4	+1·8
α Ceti	14	0·00	4	+0·4
α Persei	5	−0·06	3	−0·2
α Tauri	16	−0·02	9	+0·2
α Aurigæ	5	−0·01	6	−0·6
β Orionis	8	0·00	7	+0·4
β Tauri	5	+0·05	6	+2·5
α Orionis	8	+0·02	5	+1·4
α Canis Majoris	8	−0·02	20	−0·4
α Geminorum	10	+0·12	9	+1·8
α Canis Minoris	11	+0·03	10	+0·4
β Geminorum	17	−0·01	10	+0·3
α Hydræ	12	+0·04	7	−2·1
α Leonis	16	+0·01	12	+1·1
α Ursæ Majoris	5	+0·32	12	+0·6
β Leonis	11	+0·07	6	−0·3
β Virginis	11	+0·12	5	−0·4
γ Ursæ Majoris	5	+0·21	2	+0·2
α Virginis	15	+0·06	15	−1·2
η Ursæ Majoris	10	+0·06	3	−1·4
α Böotis	7	+0·02	2	+0·4

Name of Star.	Number of Observations.	F.—W. R.A. s	Number of Observations.	F.—W. Decl. "
α^1 Libræ	1	+0·04	5	−0·4
α^2 Libræ	11	+0·10	3	−0·6
β Ursæ Minoris	1	−0·26	6	−0·5
α Coronæ	10	+0·01	3	−0·7
α Serpentis	12	+0·01	3	−0·4
α Scorpii	12	+0·14	7	−0·2
α Herculis	9	−0·08	1	−0·2
α Ophiuchi	18	−0·02	9	−0·1
γ Draconis	9	+0·07	4	−0·8
α Lyræ	13	+0·05	8	−0·4
γ Aquilæ	15	−0·06	6	−0·7
α Aquilæ	19	−0·03	9	+0·3
β Aquilæ	15	+0·03	6	−0·5
α^1 Capricorni	1	+0·07	2	−1·8
α^2 Capricorni	7	+0·04	5	−2·8
α Cygni	24	−0·05	6	−2·4
α Cephei	11	−0·07	8	+0·9
β Cephei	4	−0·11	10	+0·2
α Aquarii	23	−0·05	3	−0·8
α Piscis Austrini	9	−0·02	8	−0·4
α Pegasi	14	−0·02	7	−0·5
α Ursæ Minoris	14	−0·20	7	+0·3
δ Ursæ Minoris	4	+0·48	10	+1·8

[*Note by Mr. Main.* Of the anomalous results in R.A., referred to by Dr. Wolfers, I may state that the R.A. of *Arcturus*, included in the Catalogue of Stars for 1860, should be rejected, as the number of determining clock-stars is too small. It has crept in by inadvertence. In addition to this, there must have been something singularly wrong in the observation, as will be immediately seen by comparing the clock-error given by it with that given by η *Böotis* (Nov. 21). Of the rest, the R.A.'s of *Aldebaran*, *Procyon*, γ *Ursæ Majoris*, and *Antares*, depend on single observations.

The anomalous cases occurring in 1860, October 11 and November 21, had been scrutinised before the observations passed the press; and the anomalies are due to strange errors in the observations, not to errors in the reductions.

In future years much better means will be given for the continuation of Dr. Wolfers' researches on the places of the fundamental stars, as clock-errors are determined by the same list of stars as that used at Greenwich, and the assumed equinox will be identical with the Greenwich assumed equinox.]

For the following abstract of Mr. Auwers' paper, On the Irregularities of the Motion of *Procyon*, and on the Determination of the Elements of an obscure Companion of *Procyon*, the attraction of which will explain these irregularities, the Society and myself are indebted to W. T. Lynn, Esq., Assistant of the Royal Observatory of Greenwich.

It may be necessary to correct a misunderstanding that might possibly be produced in the minds of some readers by the expressions of the first paragraph. The irregularities in the annual motions of stars generally, and of *Procyon* in particular, were first pointed out by Mr. Pond. In the *Greenwich Observations*, 1820–22, is a Table of "Right Ascensions of the 36 Stars of the Greenwich Catalogue, reduced to the beginning of the year 1819, from five years' observations with the new Transit Instrument, 1817–1821, and compared with Dr. Maskelyne's Catalogue of the year 1805 brought up to the same period;" the principal discordances are those of α^2 *Capricorni*, *Sirius*, *Spica*, *Procyon*. In the *Greenwich Observations*, 1825, is "A Table showing the difference between the predicted and observed N.P.D. of 45 principal fixed stars for the year 1826;" the principal discordances are those of α *Pegasi*, γ *Aquilæ*, *Sirius*, *Procyon*. In the *Philosophical Transactions*, 1823, page 36, Mr. Pond says, "A very great deviation in N.P.D. will be found in three very bright stars, *Capella*, *Procyon*, and *Sirius;*" in page 44 he again specifies *Procyon* and *Sirius*, and in page 529, he speaks of the impossibility of exactly interpolating or predicting a star's place. Finally, in the Introduction to the Catalogue of 1112 stars, dated June 27, 1833, he says, "We can hardly desire a better test of our power of predicting the future position of the stars, than by trying by the same formulæ how accurately we can interpolate for the past. In a variety of papers, which I have submitted at times to the Royal Society, I have endeavoured to show that *with us* the latter experiment entirely fails."

G. B. Airy.

Abstract of the Paper by Auwers on the Proper Motion of Procyon, contained in Nos. 1371, 1372, *and* 1373, *of the Astronomische Nachrichten.*

In this paper Auwers first gives the history of the investigations made into the proper motions of *Sirius* and *Procyon* thus: Bessel discovered in 1844 that the observed Right Ascensions of *Sirius* and Declinations of *Procyon* negatived the existence of an invariable Proper Motion of those stars, and showed that its variability was to be explained by the attraction of bodies connected with them, and forming thereby binary systems, the remaining components of which were not perceptible to us, or at least had not hitherto been perceived. Doubt was on various sides thrown upon this result, new,

surprising, and founded as it was upon very small quantities, measurable only by means of very frequently repeated observations, until Peters in 1851 demonstrated that the irregularities in the observed Right Ascensions of *Sirius* were such that they could be completely explained by the assumption of a periodical motion about a neighbouring point, itself in uniform motion; further proof of this explanation has since been afforded by investigation of the observed Declinations of that star. The argument for the existence of a similar variability in the Proper Motion of *Procyon* was greatly increased when Mädler in 1851 showed that irregularities were evidenced in its observed Right Ascensions as well as Declinations. Up to the present time, however, the question, as regards *Procyon*, has been considered an open one; Auwers, therefore, last year (1861) undertook and executed a new investigation of it, the principal features of which are contained in the paper before us, and the result of which has completely, he tells us, confirmed Bessel's hypothesis.

In this investigation he has made use of all the available published observations of *Procyon* from 1750 to 1860, using for stars of comparison in R.A. *α Tauri*, *β*, *α Orionis*, *β Geminorum*, *α Hydræ*, and *α Leonis*; and in N.P.D. *α Ceti*, *α Orionis*, *α Serpentis*, *γ*, *α*, *β Aquilæ*, and *α Aquarii*. The latter list agrees with Bessel's, save that Auwers has omitted *β Virginis*, because it has only exceptionally been observed at the English Observatories. The comparison is effected by comparing the observed place of each star with its computed place in the *Tabulæ Regiomontanæ*. After giving several tables of the results obtained from observations during the above-mentioned times, made principally at Greenwich (Bradley, Maskelyne, Pond, and Airy), Königsberg, Edinburgh, Oxford, Cambridge, Geneva, and Washington, he remarks that inspection alone is sufficient to prove the certainty of changes in the Proper Motion, and therefore he need only occupy himself with the question whether these changes are capable of being explained by the assumption of a motion in a binary system. And he finds that the irregularities are of the nature that they may be explained by the assumption of a circular motion of *Procyon*, in a plane perpendicular to the line of sight, round a point about 1″·2 distant. After trying this assumption and correcting it according to the method of least squares, he at last forms the following set of elements of the motion of *Procyon*:—

		Probable Error.
Epoch of Minimum R.A.	= 1795·5676	± 0ʸ·4457
Yearly Motion	= 9°·00634	0°·09110
Periodic Time	= 39ʸ·972	0ʸ·4043
Radius of Orbit	= 1″·0525	0″·0275

Then follows a Table containing a comparison of these ex-

pressions with observations, which shows "that the representation of the latter by the elements is perfectly satisfactory," there being no remarkable deviation in any part of the orbit, but the differences from observation having the character of being fortuitous, and following no law.

In order to be able to assign a limit to the mass of the invisible companion of *Procyon*, he has deduced a provisional approximate value of the parallax of that star from a series of observations with the Königsberg heliometer, not originally commenced with any view to such a determination. He has thus obtained for that parallax the value $0''\cdot123$, with the probable error $\pm\ 0''\cdot033$; "with this number," he says, "we should find from the above elements that the mass of the dark body must be greater than 0·4 that of the Sun. We may assume with certainty that the parallax of *Procyon* is less than $0''\cdot2$; in any case therefore the dark body must have a mass at least a hundred times as great as that of *Jupiter*. If *Procyon* and its companion have equal masses, that of each must be greater than 0·37 that of the Sun, and if the mass of *Procyon* is equal to that of the Sun, that of its companion must be greater than 0·6 that of the Sun."

The paper concludes with a table of the corrections to be applied according to this theory to the Right Ascensions and Declinations of *Procyon* in the *Tabulæ Reductionum* from the year 1750 to 1880.

W. T. L.

Rule for the Solution of Kepler's Problem.

By M. de Gasparis.

(*Communicated by the President.*)

Exemple. Soit $M = 27^\circ\ 12'\ 33''\cdot62 = E - (9\cdot8947213)\sin E$.

Je pose $A = 9\cdot3471561$, qui s'obtient en otant log. *e* du nombre 9·2418774, qui est le logarithme de 10° en parties du rayon.

Après cela l'on prend les $\log \frac{\sin(M+10^\circ)}{1}$, $\log \frac{\sin(M+20^\circ)}{2}$, $\log \frac{\sin(M+30^\circ)}{3}$, etc., et l'on s'arrête lorsque le résultat est proximément $> A$.

Le but de cette opération est d'approcher E à 10° près. Il suffit donc d'envisager les premiers chiffres, et pourvu que l'on sache les premiers chiffres des logarithmes des nombres simples,

l'opération se fait à vue d'œil. L'on trouve E $=67^\circ\ 12'$ à 10° près. Et E$-$M$=*$ 4 dixaines de degré. L'on poursuit ainsi

Log sin $67^\circ\ 12' = 9{\cdot}965$	Log $77^\circ\ 12' = 9{\cdot}989$
Log $*$ 4 $= 0{\cdot}602$	Log $5 = 0{\cdot}699$
$9{\cdot}363$	$9{\cdot}290$

Maintenant pour 73 différence entre ces deux derniers logarithmes, la variation de E est $10 \times 1^\circ$; pour 16, différence entre 9·363 et A, la variation de E est $* \ 2 \times 1^\circ = 2^\circ$. Donc E$=69^\circ\ 12'$ a 1° près.

Log sin $69^\circ\ 12' = 9{\cdot}9707$	Log sin $70^\circ\ 12' = 9{\cdot}9735$
Log $*$ 42 $= 1{\cdot}6233$	Log $43 = 1{\cdot}6335$
$8{\cdot}3474$	$8{\cdot}3400$

$74 : 10 \times 6' :: 3 : * \ 0 \times 6' = 0'$ Donc E $= 69^\circ\ 12'$ à $6'$ près,

ici l'on a pris la différence de 8·3474 avec A$-$1.

Log sin $69^\circ\ 12'\ 30'' = 9{\cdot}97075$	Log $69^\circ\ 18'\ 30'' = 9{\cdot}97104$
Log $*$ 420 $= 2{\cdot}62325$	Log $421 = 2{\cdot}62428$
$7{\cdot}34750$	$7{\cdot}34676$

$74 : 10 \times 36'' :: 34 : * \ 4 \times 36'' = 2'\ 24''$ Donc E $= 69^\circ\ 14'\ 54''$ à $36''$ près,

ici l'on a pris la différence de 7·34750 avec A$-$2, et l'on a pris le log sin $69^\circ\ 12'\ 30''$ au lieu de log sin $69^\circ\ 12'$ pour tenir compte des secondes comprises dans M.

L'on doit remarquer que l'on a approché E à $36''$ sans avoir du tenir compte des parties proportionnelles des logarithmes pris dans les tables. On pourrait dire de même jusqu'à l'approximation à $3''{\cdot}6$.

Log sin $69^\circ\ 14'\ 57'' = 9{\cdot}970872$	Log sin $69^\circ\ 15'\ 33'' = 9{\cdot}970900$
Log $*$ 4204 $= 3{\cdot}623663$	Log $4205 = 3{\cdot}623766$
$6{\cdot}347209$	$6{\cdot}347134$

$75 : 10 \times 3''{\cdot}6 :: 53 : * \ 7 \times 3''{\cdot}6 = 25''{\cdot}2$ Donc E $= 69^\circ 15' 22''{\cdot}2$ à $3''{\cdot}6$ près.

* It is to be noticed that the proportions which give the numbers which the author has thus marked, with an asterisk, depending on a multiplication by 10, and a division where the quotient is taken to a single figure only, are solved at sight. — Ed.

Log sin 69°15′22″·82 = 9·9708926	Log sin 69°15′26″·42 = 9·9708955
Log ✱ 42047 = 4·6237350	Log 42048 = 5·6237453
5·3471576	4·3471502

74 : 10 × 0″·36 :: 15 : ✱ 2 × 0″·36 = 0″·72 E = 69°15′23″·54 à 0″·36 près.

Log sin 69°15′23″·54 = 9·9708932	Log sin 69°15′23″·90 = 9·9708935
Log 420472 = 5·6237371	Log 420473 = 5·6237381
4·3471561	4·3471554

7 : 10 × 0″·036 :: 0 : ✱ 0 × 0″·036 = 0 E = 69°15′23″·54 à 0″·01 près.

Pour les grandes excentricités la différence, qui dans cet exemple est 74, est proximément constante. Cela peut servir pour controle dans les calculations.

Enfin, il est plus long d'expliquer cette règle, que de la mettre en pratique.

Naples, 21 *Mai*, 1862.

Observations of the Planet Neptune, made with the Olcott Meridian Circle, at the Dudley Observatory, Albany, U.S.A. By G. W. Hough, Assistant.

(*Communicated by Prof. Mitchell through the Astronomer Royal*).

1862.	M.T. Dudley Observatory. h m s	App. R.A. h m s	App. Decl. ° ′ ″
Sept. 24	11 46 54·61	.....	−1 13 44·76
25	11 42 52·65	0 2 45·70	1 14 25·34
28	11 30 46·79	0 2 27·51	1 16 25·03
Oct. 3	11 10 37·29	0 1 57·46	1 19 41·17
8	10 50 28·42	0 1 28·05	1 22 51·17
9	10 46 26·66	0 1 22·18	
14	10 26 18·78	0 0 53·76	1 26 29·20
28	9 30 4·42	23 59 41·92	1 33 59·68
29	9 26 3·94	23 59 37·34	1 34 27·89
Nov. 18	8 6 12·93	23 58 24·31	1 41 45·60
19	8 2 14·52	23 58 21·81	1 42 0·50
22	7 50 19·74	23 58 14·74	1 42 38·27
25	7 38 25·94	23 58 8·67	1 43 10·80
26	7 34 28·37	23 58 7·0	1 43 20·93
30	7 18 38·92	23 58 1·18	1 43 46·47
Dec. 2	7 10 44·88	23 57 58·96	1 43 56·49
3	7 6 48·04	23 57 58·02	1 43 58·16
14	6 23 31·28	23 57 56·39	1 43 42·84
17	6 11 45·83	23 57 58·59	1 43 20·11
18	6 7 50·91	23 57 59·59	1 43 11·63
21	5 56 6·92	23 58 3·34	1 42 37·10
24	5 44 24·05	23 58 8·21	1 41 59·02
30	5 21 1·61	23 58 21·28	−1 40 17·91

Date. 1861.	R.A. Correction to Amer. Eph.	R.A. Correction to Naut. Alm.	N.P.D. Correction to Amer. Eph.	N.P.D. Correction to Naut. Alm.
	s	s	″	″
Sept. 24	...	...	+10·41	+4·98
25	−1·63	−0·81	11·09	5·68
28	1·60	0·80	11·68	6·23
Oct. 3	1·56	0·78	12·23	6·76
8	1·50	0·71	11·97	6·43
9	1·57	0·79		
14	1·63	0·88	11·40	6·17
28	1·56	0·81	9·94	4·52
29	1·53	0·78	9·64	4·23
Nov. 18	1·53	0·84	10·40	5·41
19	1·47	0·78	10·80	5·87
22	1·52	0·81	9·73	4·89
25	1·59	0·89	10·44	5·61
26	1·50	0·81	11·57	6·71
30	1·48	0·79	9·11	4·20
Dec. 2	1·51	0·82	10·00	5·09
3	1·54	0·82	8·36	3·53
14	1·49	0·85	11·14	6·47
17	1·50	0·85	10·93	6·13
18	1·49	0·85	11·53	6·74
21	1·48	0·86	9·30	4·60
24	1·47	0·87	10·80	6·13
30	−1·51	−0·91	+10·83	+6·11

	R.A. Mean Correction to Amer Eph.	R.A. Mean Correction to Naut. Alm.	N.P.D. Mean Correction to Amer. Eph.	N.P.D. Mean Correction to Naut. Alm.
	s	s	″	″
Sept. and Oct.	−1·57	−0·79	+11·04	+5·63
Nov.	−1·52	−0·82	+10·17	+5·45
Dec.	−1·50	−0·85	+10·36	+5·60
Mean Day. Nov. 17	−1·529	−0·824	+10·52	+5·56

From these results it is readily seen that neither Ephemeris represents the motion of the planet correctly in R.A. The variation for 100 days is $+0^{s}\cdot109$ for the American Ephemeris, and $-0^{s}\cdot087$ for the *Nautical Almanac*. By applying the variation, the probable error for a single observation is $0^{s}\cdot029$ for the American Ephemeris, and $0^{s}\cdot025$ for the *Nautical Almanac*.

In Declination the probable errors are $0''\cdot80$ and $0''\cdot79$. The transits on October 28th, November 19th, and December 2d, were observed on 9, 10, and 7 wires respectively. In all the other observations 15 wires were used, and the times of transit recorded in on the Chronograph. Any change in the rate of the Clock (during the time of observation) was satis-

factorily determined by comparison with two other Clocks, by causing their pendulums to make records on the Chronograph at intervals of 30 minutes.

In converting the chronographic records into time, every wire was measured to the hundredth of a second. But in the "mean" and all subsequent reductions the thousandths were retained, being rejected in the final result only.

N.B. The observations published in the *Monthly Notices*, vol. xxii., No. 1, pages 18 and 19, were not corrected for parallax.

Results of the Meridional Observations of Small Planets; Occultations of Stars by the Moon; and Transit of Jupiter's Third Satellite; observed at the Royal Observatory, Greenwich, from June to September, 1862.

(*Communicated by the Astronomer Royal.*)

Hebe (6).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
	h m s	h m s	° ′ ″
1862, June 14	10 57 12·3	16 29 6·40	90 4 8·51
16	10 47 32·6	16 27 18·25	90 9 8·15
27	9 55 27·9	16 18 27·14	90 51 1·69
28	9 50 50·7	16 17 45·68	90 55 57·26
July 2	9 32 34·3	16 15 12·55	91 17 34·97

Iris (7).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
	h m s	h m s	° ′ ″
1862, Aug. 18	13 33 11·0	23 21 26·92	83 8 41·41
19	13 28 43·3	23 21 15·01	83 8 2·01
27	12 52 6·6	23 16 4·78	83 11 48·47
28	12 47 26·2	23 15 20·15	83 13 28·23
Sept. 3	12 19 3·5	23 10 32·15	83 28 30·87
10	11 45 29·2	23 4 28·13	83 56 38·05
11	11 40 40·6	23 3 35·32	84 1 28·79
16	11 16 39·9	22 59 13·45	84 28 14·24
17	11 11 52·9	22 58 22·24	84 34 1·23
19	11 2 20·9	22 56 41·71	84 46 0·53
22	10 48 18·9	22 54 17·04	85 4 48·02
23	10 43 26·8	22 53 30·75	85 11 12·95
25	10 34 6·3	22 52 1·86	85 24 12·32

Parthenope (11).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
h m s	h m s	° ′ ″
1862, July 12 13 14 56·0	20 37 36·38	107 42 16·40
19 12 41 44·7	20 31 55·46	108 22 12·61
25 12 12 50·4	20 26 35·74	108 58 3·46
26 12 8 0·1	20 25 41·28	109 4 5·79
31 11 43 49·0	20 21 8·92	109 33 48·05
Aug. 14 10 37 20·2	20 9 41·02	110 49 0·21
25 9 47 58·0	20 3 32·82	111 34 16·79
29 9 30 52·5	20 2 11·12	111 46 55·66

Egeria (13).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
h m s	h m s	° ′ ″
1862, Sept. 3 13 13 57·2	0 5 34·78	112 56 10·43
16 12 9 59·9	23 52 42·22	113 39 0·57
22 11 40 10·8	23 46 27·48	113 46 56·83

Melpomene (18).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
h m s	h m s	° ′ ″
1862, June 4 9 45 33·4	14 37 50·13	89 43 58·59

Pomona (32).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
h m s	h m s	° ′ ″
1862, Sept. 16 12 50 23·2	0 33 12·16	81 2 57·88
17 12 45 41·7	0 32 26·45	81 8 50·69
22 12 22 6·3	0 28 29·95	81 39 31·59
25 12 7 52·5	0 26 3·41	81 59 10·24

Lætitia (39).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
h m s	h m s	° ′ ″
1862, June 30 12 18 37·6	18 53 50·02	99 6 56·01
July 12 11 21 13·5	18 43 35·15	99 47 53·86
19 10 48 5·8	18 37 57·94	100 18 55·68

Aglaia (47).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
h m s	h m s	° ′ ″
1862, Sept. 22 12 48 2·2	0 54 30·10	83 23 40·08

Doris (49).

Mean Solar Time of Observation.	R.A. from Observation.	N.P.D. from Observation.
h m s	h m s	° ′ ″
1862, July 19 12 28 6·5	20 18 15·04	101 3 11·11
31 11 31 50·3	20 9 8·23	101 42 25·34
Aug. 7 10 59 14·1	20 4 2·63	102 8 7·76
19 10 4 31·3	19 56 29·43	102 53 33·09
22 9 51 12·9	19 54 58·60	103 4 57·07
25 9 37 58·4	19 53 31·61	103 15 57·14

All the observations of N.P.D. are corrected for refraction and parallax.

Occultations of Stars by the Moon.

Day of Obs.	Phenomenon.	Moon's Limb.	Mean Solar Time. h m s	Observer.
1862, July 15	κ Piscium reapp. (*a*)	Dark	11 25 20·6	E.
15	9 Piscium reapp. (*a*)	Dark	11 30 22·8	E.
21	υ^1 Tauri reapp.	Dark	14 56 59·3	T. C.
Sept. 3	π Sagittarii disapp.	Dark	11 45 23·2	C.

(*a*) Observed through thin cloud; considered true to a second.

The initials E., C., and T. C., are those of Mr. Ellis, Mr. Criswick, and Mr. Chappell.

The egress of *Jupiter's* third Satellite was observed on June 16, by Mr. Ellis, to take place at $10^h\ 22^m\ 17^s\cdot 2$, M.S.T.

Measures of the Planet Mars, made, at the Opposition of 1862, *with the Heliometer at the Radcliffe Observatory, Oxford, for the Determination of the Ellipticity of the Disk.* By the Rev. R. Main. (Abstract.)

This paper, which is accompanied by eleven drawings of the planet *Mars*, gives the results of eighteen sets of measures made by Mr. Main for the purpose of determining the ellipticity and size of the planet. Each set of observations consists of at least ten measures of the polar, and ten of the equatoreal diameter, and each result is rigorously corrected for defective

illumination of the disk in the direction of each diameter, and for the corresponding effects of refraction.

The results arrived at are as follows :—

Day, 1862.	Corrected Equatoreal Diameter.	Corrected Polar Diameter.	Ellipticity.		Equatoreal Diameter at Unit of Distance.
Sept. 18	22″·386	21″·872	0·02296	$\frac{1}{43·55}$	9″·25
19	22·987	22·374	·02667	$\frac{1}{37·50}$	9·47
22	22·978	22·729	·01084	$\frac{1}{92·28}$	9·39
23	22·914	22·162	·03282	$\frac{1}{30·47}$	9·34
25	23·112	22·576	·02319	$\frac{1}{43·12}$	9·39
27	23·131	22·543	·02542	$\frac{1}{39·34}$	9·39
30	23·018	22·924	·00408	$\frac{1}{244·87}$	9·35
Oct. 8	22·674	22·208	·02055	$\frac{1}{48·66}$	9·38
9	22·780	22·314	·02046	$\frac{1}{48·88}$	9·46
11	22·564	22·230	·01480	$\frac{1}{67·56}$	9·45
15	21·734	21·385	·01606	$\frac{1}{62·28}$	9·31
16	21·668	21·296	·01717	$\frac{1}{58·25}$	9·34
17	21·659	20·938	·03507	$\frac{1}{28·51}$	9·42
18	21·495	20·828	·03103	$\frac{1}{32·23}$	9·39
20	21·034	20·775	·01231	$\frac{1}{81·21}$	9·33
22	20·830	20·419	·01973	$\frac{1}{50·68}$	9·39
23	20·774	20·267	·02556	$\frac{1}{39·12}$	9·44
26	19·942	19·389	·02773	$\frac{1}{36·06}$	9·31
Means	.....	.....	0·02147	$\frac{1}{46·58}$	9·38

The ellipticity requires correction for the depression of the Earth below the plane of the equator of *Mars*. When this correction is applied, the ellipticity is finally $\frac{1}{39·04}$.

The angular diameter at the unit of distance, namely, 9″·38, corresponds to a real diameter of 4332 miles, but this still requires correction for the effect of irradiation. For the determination of the irradiation, Mr. Main proposes to make observations when the disk of *Mars* has become small.

Places derived from Observations of Comet II., 1862, *made with the Heliometer at the Radcliffe Observatory, Oxford.* By the Rev. R. Main.

Day, 1862.	Greenwich Mean Solar Time.	Apparent R.A.	Apparent N.P.D.
	h m s	h m s	° ′ ″
Aug. 5	9 47 4·0	6 22 30·07	13 54 8·5
,,	10 50 33·6	6 22 47·52	13 52 5·7
7	10 7 18·7	6 41 39·76	12 27 27·6
9	9 29 3·4	7 9 12·24	10 58 10·3
,,	9 47 36·3	7 9 29·07	10 57 35·2
,,	10 17 8·5	7 9 46·80	10 56 46·9
,,	10 31 9·2	7 9 55·67	10 56 8·0
,,	10 40 23·4	7 10 2·31	
,,	10 48 14·9	7 10 9·44	10 55 46·4
,,	11 1 23·2	7 10 18·41	10 55 19·0
14	8 59 7·2	9 42 3·32	8 0 3·3
18	10 55 26·9	12 57 38·98	10 55 12·0
19	11 21 32·6	13 31 51·60	13 13 46·0
22	9 30 26·2	14 35 49·24	21 2 46·9
,,	9 49 40·7	14 36 1·31	21 5 3·1
,,	10 13 21·2	14 36 16·01	21 8 29·0
,,	10 27 41·9	14 36 25·30	21 10 20·3
23	9 47 30·1	14 49 59·60	24 41 36·5
25	9 53 43·8	15 12 9·44	33 14 38·6
29	8 51 22·9	15 36 43·24	54 37 19·8
,,	9 11 38·1	15 36 46·05	54 42 30·9
,,	9 37 15·2	15 36 52·64	54 48 51·8
,,	9 50 20·5	15 36 54·11	54 52 3·7
,,	10 8 10·4	15 36 57·17	54 56 17·8
,,	10 31 30·1	15 37 2·18	55 1 46·9

Assumed Mean Places of the Stars employed for Comparison.

Day of Obs.	Star's Name.	Mean R.A. 1862, Jan. 1.	Mean N.P.D. 1862, Jan. 1.
		h m s	° ′ ″
Aug. 7	B.A.C. 2210	6 39 53·16	12 51 22·0
9	B.A.C. 2210		
,,	Radcliffe 1928	7 11 28·81	11 2 20·5

Day of Obs.	Star's Name.	Mean R.A. 1862, Jan. 1.	Mean N.P.D. 1862, Jan. 1.
		h m s	° ′ ″
Aug. 14	Groomb. 1643	10 21 35·42	8 47 50·2
18	B.A.C. 4527	13 25 49·48	10 38 35·1
19	Oeltz. Arg. 13813	13 30 39·48	13 13 45·5
22	Groomb. 2129	14 28 33·63	21 18 31·1
25	Groomb. 2211	15 10 2·56	33 21 57·2
29	Piaz. xv. 148	15 33 28·78	54 52 20·2

The observations in general consisted of distinct readings of the hour-circle, and the declination circle corresponding to distinct transits and bisections of the Comet, and the comparison-stars, except on August 9, when the transits of the star and Comet were made with an unchanged position of the polar axis, the objects being in the field of the telescope together.

The results on August 5 and 23 are more doubtful than the rest through want of a comparison-star.

The observations to August 14, inclusive, were made by myself; after that time they were made by Mr. Quirling.

Observations of Comet II. 1862, *taken with the Equatoreal of the Liverpool Observatory.* By J. Hartnup, Esq.

1862.	G.M.T.	Comet's R.A.	Log. $\frac{p}{P}$	Comet's N.P.D.	Log. $\frac{q}{P}$	Stars of Comp. B.A.C.
	h m s	h m s		° ′ ″		
Aug. 18	8 11 55·9	12 53 13·87	+9·309	10 48 14·0	+8·2211	4527
18	8 57 3·3	12 54 25·25	+9·323	10 51 20·6	−8·9740	,,
18	9 42 8·7	12 55 36·51	+9·321	10 54 28·6	−9·3168	,,
21	9 57 5·7	14 18 44·38	+9·107	17 55 10·8	−9·3093	4909
21	10 37 31·9	14 19 17·06	+9·110	18 0 14·4	−9·3688	,,
23	8 11 41·9	14 49 11·09	+8·864	24 26 13·6	+8·1605	4949
23	8 26 47·7	14 49 19·24	+8·887	24 28 41·1	−7·7688	,,
23	8 41 54·3	14 49 26·93	+8·905	24 31 4·4	−9·3188	,,
28	9 12 11·0	15 31 41·35	+8·656	48 53 23·1	−9·6022	5122
28	9 32 12·7	15 31 45·58	+8·676	48 58 11·9	−9·6345	,,
28	9 52 14·6	15 31 50·10	+8·693	49 3 1·1	−9·6655	,,
Sept. 10	10 27 23·6	16 8 0·19	+8·514	108 46 30·4	−9·9433	6060

The observations are corrected for refraction. The corrections to be applied for parallax in time, and are represented by p and q. P is the equatoreal horizontal parallax.

The following are the assumed mean places of the stars of comparison for 1862, January 0 :—

	R.A.	N.P.D.	Authority.
	h m s	° ′ ″	
B.A.C. 4527	13 25 49·25	10 38 35·39	British Association Catalogue.
,, 4909	14 45 7·31	17 27 30·68	,, ,, ,,
,, 4949	14 55 24·07	23 31 2·37	,, ,, ,,
,, 5122	15 25 58·19	48 41 38·95	,, ,, ,,
,, 6060	17 47 47·94	108 46 23·90	,, ,, ,,

Remarks.

Aug. 18. Nucleus stellar, small and well defined. Tail in large telescope fan-shaped, short, and very bright. In a good opera-glass the tail appeared about 8 degrees long.

23. In the large telescope, with powers 90, 120, and 400, the nucleus was elongated, well defined, small, and bright. In the finder (power 20) the nucleus appeared round, and resembled a star of the 5th magnitude, surrounded with faint nebulous light.

28. Nucleus not so bright as on the 23d, but still well defined and a little elongated. Light of comet more diffused.

Sept. 10. Comet found with an opera-glass. In the large telescope the light was much more diffused than on previous occasions.

Observations of Comet II., 1862. By G. Knott, Esq.

The late fine (and in some respects remarkable) Comet was first seen at this Observatory on August 18th. Unfortunately I was a good deal away from home during its apparition; and this circumstance, coupled with the unsettled state of the weather, prevented my observing it so closely as I should otherwise have done.

At the suggestion of the Rev. T. W. Webb, I measured, or carefully estimated, whenever opportunity offered, the position-angle of the curious fan or jet which streamed from the nucleus; and although I am not inclined to attach much weight to my results, I think they abundantly suffice to show remarkable variations in the direction of the fan, to the extent of more than 50°. The measures were made with a wire micrometer attached to my 7½-inch Equatoreal, the power employed being 113; and in all cases, unless otherwise stated, the angle is that of a central chord of the jet.

I proceed to give a few extracts from my journal :—

"August 18th. My first view of the comet in the Equatoreal. The nucleus is bright and sharply defined; bears magnifying well. A curious ray or jet proceeds from it, having a position-angle of 280° or 285°.

"August 25th. The nucleus evidently not in the centre of the coma. The jet is much curved. A tangent to the jet near the nucleus would have a position-angle of 235° or 240°.

"August 27th. A fine evening. With the naked eye the tail can be traced for about 20°. In the telescope the tail appears to be double. The inner edge of the longer and brighter branch is sharply defined; one measure gave its initial position-angle $=75°$. The southern branch short and ill-defined. At $8^h\ 45^m$ G.M.T. five measures gave the position-angle of jet $=241°{\cdot}5$. Later in the evening, $10^h\ 40^m$, the position-angle deduced from five measures was $240°{\cdot}8$; approximate length of jet, $46''\pm$.

"August 29th. Apparently an extraordinary change in the form of the jet. The nucleus very bright, sharply defined, and of an orange tint. The position-angle deduced from five measures at $8^h\ 30^m$ was $279°{\cdot}0$. Clouds now came up, and further observation was impossible.

"August 30th. The jet appears to have recovered its usual form. The nucleus and jet not well defined; the position-angle of the latter at $9^h\ 30^m$ estimated at 225°. Later in the evening took measures: the mean of five gave the angle at $10^h\ 7^m = 225°{\cdot}6$. This was the last occasion on which I saw the Comet."

The marked changes in the position-angle of the jet are sufficiently curious, and I much regret that circumstances did not allow me to obtain a more complete series of measures. I can only hope that other observers have been more fortunate.

Woodcroft Observatory, Cuckfield, Nov. 11, 1862.

Observations of Comet II., 1862. By F. Abbott, Esq.

I herewith send you the approximate positions of a fine Comet, which first made its appearance here at the early part of the month. From the 1st to the 6th the sky was so unusually cloudy as to entirely shut out the Moon's place, and also from the 6th to the 11th, from the latter date it was observed every evening with one exception, the results were chiefly obtained with the first trial of a Dallmeyer's portable Equatoreal, just imported—no correction having been made for instrumental error or refraction — the positions, however, were generally taken near the zenith.

The small sketch enclosed, taken on the 11th, will convey some idea as to the Comet's general appearance. On the 6th, it was distinctly seen in a clear sky with a Moon thirteen days old. On the 11th some measures were made on its curved tail,

about 5° in length, 40′ in diameter, with a planetary nucleus of 20″; on this evening δ *Scorpii* was seen doubly through the tail clear and well defined. On the evening of the 12th the condensed head of the Comet covered the small nebula marked 80 *Messier*, which nebula could not be seen at this time by any means I could adopt. On the 21st the Comet had apparently diminished so much as to be just visible to the naked eye when pointed out, and on the 22d it became telescopic.

		R.A.	Decl.
	h m	h m	° ′
1862, Sept. 6	6 30 P.M.	15 59	4 0 S.
11	8 30 ,,	16 10	19 40
12	7 20 ,,	16 11	22 30
14	10 10 ,,	16 13	26 25
15	7 10 ,,	16 14	27 30
16	10 30 ,,	16 15	29 20
17	7 35 ,,	16 16	31 10
18	7 15 ,,	16 17	32 0
19	7 35 ,,	16 18	33 30
20	7 45 ,,	16 19	34 30
21	7 30 ,,	16 20	35 50 S.

Private Observatory, Hobart Town, Sept. 23, 1862.

On the Cluster x Crucis, R.A. $12^h\,43^m\,36^s$, *N.P.D.* 149° 25′ 31″ (3435, *H.*) *Lac.* 1110 (*Neb.*). By F. Abbott, Esq.

This delightful cluster, "which is estimated by Sir J. Herschel to be composed of from 50 to 100 stars," most of which partake of well-marked and varied colours, forms an object that is scarcely perceptible to the naked eye, but when under proper optical influence it is one of the most brilliant and interesting objects in the Southern sky.

This cluster is not only an object of interest from the extreme beauty of colour and arrangement, but with respect also to certain changes that are apparently taking place in the number, position, and colour of its component stars.

Some hesitation might be felt in following the author of the *Cape Observations*, with the means he employed, were it not for the encouraging invitation that is given for other observers to note any remarkable change that may have taken place since those results were published. Having, therefore, no knowledge of any other observation being made, or popular

account published of $\varkappa$ *Crucis*, except that at Feldhausen, I have adopted it for comparison with the observations now made, and given in the drawing for the present epoch.*

The colour of all the stars, where distinct colour could be detected, is given on the drawing; the smaller stars, however, from the 10th to the 14th magnitude, are generalised, and all partake of nearly the same colour (Prussian blue), some with a little more or less tint of red or green mixed with the blue. The same Greek letters have, with one exception, been used in the drawing as those used for the Cape Monograph, but not exactly following those used in the Catalogue. The letters and numbers, when in combination, are grouped together in brackets, and intended to show colour and position only.

The 75 stars which are given in the drawing were observed, and their position laid down by means of a 5-foot achromatic telescope, with a $4\frac{1}{4}$-inch object-glass of excellent quality. The power used for the purpose of laying down the position of the stars was 135; but for the colours a comet eyepiece of 27 was found preferable.

The colours, as well as the positions, were afterwards checked with a 7-foot achromatic by Dollond. The evening of the 24th of May was chosen for confirmation: it was a capital night — no moon, quite calm, and the object near the zenith; but with such a night I was not, with the means employed, able to bring out stars of the 15th and 16th magnitude given in the Cape Catalogue.

In the *Cape Observations* φ is laid down to the west of ε and δ; they are now, however, situated in a straight line, which, when continued, reaches the star ζ; a straight line also, drawn through α and β, cuts δ; but the two conspicuous stars in the drawing, ν and θ, as well as the three small stars marked 12 above the belt, are not shown at all in the Cape Monograph; there are also two considerable stars, $\varkappa$ and λ, to the far west, which are not seen in the Cape description.

The two stars, α and β, apparently retain their colour; but ν has changed from greenish white to blueish purple; δ from green to pale cobalt; ε from red to Indian red; ζ from green to ultramarine; φ (marked η in the drawing) from blue green to emerald green; α^2, called ruddy, partakes now of much the same colour as all the small stars of that magnitude.

Private Observatory, Hobart Town,
May 1862.

* The drawing was exhibited at the November Meeting of the Society. — Ed.

On the Identity of the Triple Star H I. 13.

By the Rev. W. R. Dawes.

This object is thus described by Sir W. Herschel in his first Catalogue of Double Stars:—

"July 25, 1781. In Constellatione *Aquilæ*, near Fl. 37. A curious treble star. It is the last star of a telescopic trifolium n. following *k*, similar to that in the hand of *Aquarius*. The two nearest very unequal; the third star excessively small, and not visible with 227. The two nearest with 460, no more than half diameter of L; the farthest about 7″ or 8″."

The two nearest were measured by Sir James South at Passy in July and August 1825, with his 7-foot refractor of 5 inches aperture; but on the night of the 28th of July, which he describes as "very favourable for difficult observations," he records, "Sir W. Herschel having described it as a triple star, I applied a power of 413; but no third star could be even suspected." It is distinguished as S 720.

In the Dorpat Catalogue of 1827, Struve has thus described his No. 2541:—"2541, P. xix. 185; $\alpha = 19^h\ 27^m{\cdot}3$; $\delta = -10^\circ\ 48'$; I. (9) (10.11) = H I. 13." And his No. 2545 is described thus:—"2545, $\alpha = 19^h\ 29^m{\cdot}0$; $\delta = -10^\circ\ 32'$; I. (6) (8)."

In his "Adnotationes" at the end of the Catalogue, he remarks, with reference to "No. 2541, P. xix. 185. Hanc stellam H I. 13 posui. Est quidem egregia altera duplex classis I. in vicino, No. 2545. Sed hæc est stella magnitudinis sextæ, qualem *Herschelius* non videtur observasse. Neutram tamen triplicem vidi, qualis H I. 13 esse debet."—In his *Mensuræ Micrometricæ*, p. 80, he gives three nights' measures of No. 2541; and at p. 53, five nights' measures of No. 2545. Attached to the former is the remark,—"Dubitari potest utrum hæc stella an 2545 sit Herscheli I. 13."—Though No. 2545 was observed on five nights, on three of which power 480 was used, and on one 600, yet no third star was ever perceived.

There is a second triple star in this vicinity, No. 2547 of Struve's Catalogue. Its Right Ascension is about $12\frac{1}{2}^s$ greater than that of 2545, and it is about 11′ further south. This was observed by Struve on three nights, but *only as double*.

Sir John Herschel reobserved S 720 on three nights in 1828 and 1830. (Nos. 553–555 of the 364 Double Stars. *Mem. R. Ast. Soc.* vol. v. part i. p. 69). In one of his notes at the foot of the page he remarks, "Taken for Σ 2545;" and in another, "This is S 720. It cannot be H I. 13." *Why*, is not stated. No third star was seen on any occasion. Sir John also observed a double star which he designates Σ 2545 (No. 556 of the 364); but the angle of position differs so widely from Struve's, that either there is a large error in it, or another object has been observed, which, however, I have failed to find. No. 557 is rightly called Σ 2547, and the

position and distance agree well with Struve's; but the third star has escaped Sir John as well as Struve.

In 1835, Admiral Smyth observed two objects in this locality, which constitute Nos. 702 and 703 of the "Bedford Cycle." The former is marked as *triple;* the latter as *double only.* No. 702 is thus described:—"A delicate triple star, on the right knee of *Antinous*. . . . A 9, light yellow; B 10, cerulean blue; C 12, violet tint; and the three lie nearly in a line pointing to a distant small star in the *s. f.* quadrant."—It is stated to be P. xix. 185, and to be identical with H I. 13, with S 720, and with Σ 2541,—the positions and distances of those stars, as determined by the respective observers, being quoted for comparison. With reference to the third star overlooked by Struve and South, he adds, "It is plain enough in my refractor. I therefore conclude Sir James must have measured the following instead of 13 H I." Smyth gives as the results of his own observations of 702:—

A B	P = 338°·4 (*w*. 4)	D = 3″·2 (*w*. 2)	Epoch 1835·58
A C	153°·5 (*w*. 2)	8·0 (*w*.)	

And the mean place of the star for 1840 is given thus:—

R.A. 19h 28m 1s	Prec. + 3s·30
Decl. S. 10° 46′·8	— N. 7″·51

Of the Cycle No. 703, Smyth gives as the mean place for 1840:—

R.A. 19h 28m 5s	Prec. + 3s·30
Decl. S. 10° 30′·4	— N. 7″·52

and he considers it to be identical with P. xix. 186.

As the results of his measurements of this star he gives:—

P = 315°·7 (*w*. 6) D = 3″·8 (*w*. 3) Epoch 1835·58;

and he describes the object thus:—"A very neat double star on the right knee of *Antinous*, and closely following the above-described object. A 7½, pale white; B 9, sky-blue; and they are followed by another double star nearly on the parallel. There can be little doubt of this object's having been measured for 185 P.; for, though it is considerably brighter and more open, yet there is certainly a great resemblance in the position and distance of A and B. This is the No. 2545 of the great Dorpat Catalogue."

Wishing to determine, if possible, which of the two objects in this vicinity at all resembling H I. 13, was really that star, in October 1859 I directed toward the place my 8¼-inch re-

fractor. Having identified 37 (*k*) *Aquilæ*, which is, in fact, a good fifth magnitude star, and plainly visible to the naked eye, I carefully examined all the stars north-following 37 which were visible along with it in the finder of 2 inches aperture and power 23. The nearest double star to 37, and, with reference to that star, about 8′ 35″ n. f. $2^m\ 12^s$, was obviously Σ 2541; the second was about 24′ 44″ n. f. $4^m\ 7^s{\cdot}5$, and agreed in place with Σ 2545; and a third was about 13′ 41″ n. f. $4^m\ 20^s$, and agreed in place with Σ 2547. The mean place of 37 *Aquilæ* deduced from the B. A. C. was for 1860·0, R.A. $=19^h\ 52^m\ 52^s{\cdot}66$, and N.P.D. $= 100°\ 52′\ 52″{\cdot}5$. In referring to each of these objects I shall designate them by Struve's numbers.

Σ 2541. Instantly seen *double;* looked carefully for a third star; none could be found. Magnitudes, A = 8½; B = 9½. Pos. = 340° ±; Dist. = 2″·5 ±.

Σ 2545. Instantly seen *triple*. Mag. A = 6½; B = 8; C = 11¼, *blue*. A B, Pos. = 315° ±; Dist. = 3″·0 ±. A C, Pos. = 170° ±; Dist. = 25″ ±.

Σ 2547. Obviously *triple*. Mag. A = 7½; B = 9; C = 10½. A B, Pos. = 330° ±; Dist. = 20″ ±. A C, Pos. = 140° ±; Dist. 45″ ±. *The three are nearly in a line.*

Of these three objects, I have not the slightest doubt that the *second*, Σ 2545, is H I. 13.

The only circumstance which presents any difficulty in the way of this conclusion is, that the distance of C from A is much greater than was estimated by Sir W. Herschel. But the marvel rather is that he *discovered* it at all with his 7-foot Newtonian; and a mere guess at the distance of a scarcely perceptible point of light may easily be much in error. A similar and very remarkable instance occurs in the distance of A C of Cycle 702, which was estimated by Smyth at 8″, though its real distance is between 40″ and 50″. It was, in fact, a mere guess, with *no weight* attached to it.

That the third star of H I. 13, should have escaped the scrutiny of such observers as South, Herschel II., Smyth, and especially Struve with his powerful Dorpat refractor; and yet should have been seen at all by Herschel I. with a reflector of only 6⅓ inches aperture (about equal in light to a refractor of 4½ inches aperture), and then, after lying hid for nearly eighty years, should have been caught up at the first glance with a telescope 1½ inch smaller in diameter than Struve's (and whose illuminating power is therefore only as 68 to 92) might seem almost with certainty to point to *variability of light*, as the only probable solution of the difficulty. Yet, during three years, since 1859, I have on various occasions examined it with a special view to this point, and have never found any proof of it, or even ground of suspicion. It is true that on a very clear night (19th August, 1862) I saw it with a refractor of only 4 inches aperture by Cooke of York, and with so low a power as 135; but, on viewing it with my 8¼-inch, I found

that all the faint stars in the neighbourhood were proportionably brighter than usual from the transparency of the atmosphere. The fact that Struve on three different nights overlooked the third star of Σ 2547, of which Smyth says, "It is plain enough in my refractor," and which has three or four times the light of the third star of Σ 2545 (H I. 13) is sufficient to show how easily such objects may be rendered invisible at a small altitude by a little unsuspected haze. Yet it would be highly desirable that this object should be put upon the list of "Suspected Variables." Of course, at such an altitude, great caution is required; and it will be necessary to compare it with two or three very faint objects in its immediate vicinity.

Hopefield Observatory, Haddenham,
October 1862.

Remarks on some Astronomical Eye-pieces.

By the Rev. W. R. Dawes.

As the improvement of astronomical eye-pieces must always be interesting to telescopic observers, it is hoped that a few remarks on that subject may not be unacceptable. They will have special reference to a paper by Mr. T. W. Burr, printed in the *Monthly Notices* for June 1862, in which he particularly recommends an eye-piece lately constructed by Mr. Thornthwaite, and, in consequence of its freedom from the defects of those in ordinary use, named the "Aplanatic" eye-piece.

It does not appear to be generally known that the late Carl Kellner, of Wetzlar, in Prussian Rhine, employed the same, or very nearly the same, form for his telescopes as for his microscopes — I have seen several of them. The field-lens in all was double convex; and so nearly equi-convex (in some, at least) that I could not discover that they were not exactly so. The eye-lens was a meniscus; and they all had a stop, or diaphragm, in the focus of the meniscus, and very near the field-lens. One of these, which produced a power of 80 on my telescope, had a field of 37′ 10″ in diameter; and, consequently, the angular subtense of the diaphragm = 49° 33′. Being directed to the full moon on the 8th of November, 1851, it embraced the whole of it with a considerable margin. On that night the moon's diameter was 30′ 6″; and, consequently, the breadth of the margin all round it was 3′ 32″. The focus being carefully adjusted on a well-defined object near the centre of the moon, the edge was very distinct all round without any perceptible colour.

In the year 1855, Professor Steinheil of Munich sent me three eye-pieces, the construction of which he considered an

improvement on Kellner's; the eye-lens being rendered achromatic by being composed of a double convex of crown-glass, and a plano-concave of flint-glass, cemented together. This seems to be precisely the same combination as that of Mr. Thornthwaite's eye-lens, as described by Mr. Burr; and if so, it has already been in use for more than seven years. After many comparisons I have arrived at the conclusion, that there is little, if any, advantage in this construction over Kellner's *as made by himself.*

Mr. Burr states that "the division of double stars is rendered easier by this [aplanatic] eye-piece. . . . Persons who could not see ε *Lyræ* quadrupled with the Huyghenian of 123 had no difficulty in doing so with the aplanatic, &c." This is certainly very extraordinary. I have for many years been in the habit of showing this quadruple star, with a refractor of only $2\frac{1}{2}$ inches aperture, to persons who had never seen the object before; yet no one has ever experienced any difficulty in perceiving both pairs to be double at the same time (without bringing each into the centre of the field) with the ordinary Huyghenian eye-pieces magnifying 93 and 134 times; and, as the two pairs are only about $3\frac{1}{2}$ minutes of arc apart, this circumstance has never been supposed to indicate peculiar excellence in the eye-pieces. I have lately tried on this object with the same telescope a Huyghenian eye-piece by Tulley producing a power of 120, with which it was impossible for any one to overlook the duplicity of both sets seen at once. I presume that this condition (both pairs being seen double at the same time, and of course in different situations in the field of view) is one particularly dwelt upon in the comparison; because, if each is brought nearly into the centre, very little difference is produced in the image by the use of any of the various kinds of eye-piece, whether merely a single lens or composed of two. Under favourable atmospheric circumstances I have examined α *Lyræ* near the meridian with almost every variety of eye-piece,—the Huyghenian, Kellner's, and Steinheil's negatives, Ramsden's positive, or micrometer, both with ordinary and achromatic lenses; with double convex, crossed, plano-convex, and achromatic lenses;—but when the powers were nearly equal, I could perceive no difference in the definition of the disk, or in the formation of the optical rings round it; the object being, of course, placed in the centre of the field, and kept there by the driving-clock. It is, however, obviously of the utmost importance in arriving at a correct result in such a comparison, that the lenses should all be good. Any imperfection in their material or figure or workmanship may be immediately detected by a distortion of the disk of a bright star, or of the rings surrounding it; and the nature of the imperfection may probably be discovered by lengthening the focal adjustment considerably, when the defect will appear on the diffused image.

In reference to the size and distinctness of the field in compound eye-pieces, it is of course necessary, not only that the lenses should be good, but also that their focal lengths and distances from each other should be duly proportioned and adjusted. It is quite possible that any comparative inferiority in a compound eye-piece may arise, not so much from the character of its combination, as from some fault in its construction. For instance, — any Huyghenian eye-piece producing a power of about 125 on a good telescope of two and a half inches or more in aperture, which failed to show ε *Lyræ* quadruple, may on that very account be reasonably suspected of being imperfectly constructed, and therefore unfit to be employed as a standard of comparison for others.

I have lately had an opportunity of examining a Comet eye-piece made by Mr. T. Cooke of York on Kellner's plan, which fully comes up to the standard of those made by Kellner himself; the angular subtense of the diaphragm being nearly 50°, with remarkable distinctness and freedom from colour to the edge of the field.

In the "achromatic positives," as constructed by Steinheil, the eye-lens is a double achromatic; and there is an almost complete correction of colour to the edge of the field, which would be particularly advantageous in taking wide measures with the filar micrometer. In three which I have, however, the spherical aberration is over corrected, requiring the eye-piece to be a little withdrawn to bring the web into focus when far from the middle of the field. An eye-piece of this form, with large lenses and of low power, if correctly constructed so as to unite flatness of field with achromaticity, would make an excellent comet eye-piece; and it would be even more valuable for the annular micrometer, in which the colour infesting the objects and the edges of the rings in the micrometer, is a serious impediment to the accuracy of observation.

In the preceding remarks I have spoken of the *angular subtense* of the diaphragm of an eye-piece. This is a very useful *constant*, and may be easily determined by various processes.

1. Fix the eye-piece so that its diaphragm as seen with one eye can be projected on a wall, or a perpendicular staff, as seen with the other. Let an assistant mark the points on the wall cut by the upper and lower edges of the projected diaphragm, which will denote its apparent vertical diameter. Measure the distance between them, and also the distance of the wall from the eye, which should be opposite to the middle of the projected diaphragm. Then the angular subtense of the diaphragm will be found by the following formula:—

$$\text{Tangent } \tfrac{1}{2} \text{ angular subtense} = \frac{\tfrac{1}{2} \text{ projected diameter of diaphragm}}{\text{distance of the eye}}.$$

2. Another method of determining the same constant, and probably with greater accuracy, is by noting the time occupied by an equatoreal star near the meridian in traversing the diameter of the diaphragm of the eye-piece applied to a telescope. The magnifying power on that telescope being ascertained by a dynamometer or otherwise, the angular subtense is obtained by the formula,—

$$\text{Angular subtense} = \text{time noted} \times 15 \times \text{magnifying power.}$$

3. Where the eye-piece can be applied to an instrument having circles divided with sufficient minuteness, the diameter of the diaphragm in arc on that telescope can be obtained from the readings of the vertical circle, by bringing a star or any other well-defined object to the southern and northern extremities of the diameter, and taking the difference of the readings; then

$$\text{Angular subtense} = \text{angular diameter} \times \text{magnifying power.}$$

It is obvious that the angular subtense, or constant, of any eye-piece having been determined, the magnifying power produced by that eye-piece on any telescope may be readily found by merely observing the diameter of the field by any of the above-mentioned methods; when

$$\text{Magnifying power} = \frac{\text{angular subtense}}{\text{angular diameter}}.$$

Thus the diaphragm of an eye-piece whose *angular subtense* is 50°, if applied to one eye, and projected on the sky viewed with the other eye, would just include at the upper edge a star whose altitude is 50°, when the lower edge coincided with the true horizon. If such an eye-piece were applied to a telescope, and an equatoreal star were found to occupy two minutes in traversing the diameter of the field, the *angular diameter* on that telescope would be 30′, and the magnifying power 100.

As the focal images formed by an object-glass lie in a spherical surface of which the radius is the focal length, it is obvious that even if the spherical aberration of an eye-piece were perfectly corrected, it could not be free from the defect of indistinctness at the edge of a field of considerable extent. I am not aware that any successful attempt has been made to *over*-correct the spherical aberration of the Huyghenian eye-piece by making the *field*-lens a compound one; though there would seem to be no impossibility in the way of its accomplishment.

Hopefield Observatory, Haddenham, Thame, September 1862.

On Aluminium Bronze as a Material for the Construction of Astronomical and other Philosophical Instruments. By Lieut.-Colonel A. Strange, F.R.A.S.

The author, after referring to the Astronomical and Geodesical instruments about to be constructed, under his superintendence, by order of the Government, for the use of the Great Trigonometrical Survey of India, and after noticing that one of the points which has given him most anxiety had been the selection of the proper material or materials of which to construct these instruments, and that his present remarks were confined to the great Theodolite with a horizontal circle 3 feet in diameter, and after detailing the requirements of such an instrument, proceeds as follows:—

"Such then was the problem presented for solution: to construct an instrument with extended powers, and cast as much as possible in masses, the transportation of which, over the most difficult ground, should not be beyond the power of human labour.

"When on the point of compromising the difficulty by separating, so as to form distinct packages, parts hitherto regarded as inseparable, my attention was attracted by the various articles made of 'Aluminium Bronze' sent to the International Exhibition by Messrs. Bell Brothers, of Newcastle, and M. Morin, of Paris. The inquiries I made in various quarters satisfied me that this metal possessed most valuable qualities, but I failed in my endeavours to obtain reliable numerical data for comparing it with other metals. I therefore instituted experiments on it, the results of which I beg now to communicate to the Society.

"The alloy called Aluminium Bronze was first, I believe, made by Dr. Percy five or six years ago, and is composed of Aluminium and Copper in various proportions, 10 per cent of Aluminium, however, giving the best material for mechanical purposes.

"The qualities of most importance in instrument making are, (1) Tensile strength; (2) Resistance to compression; (3) Malleability; (4) Transverse strength or rigidity; (5) Expansive ratio; (6) Founding qualities; (7) Behaviour under files, cutting tools, &c.; (8) Resistance to atmospheric influences; (9) Fitness to receive graduation; (10) Elasticity; (11) Fitness for being made into tubes; (12) Specific gravity.

"Of these, tensile strength, resistance to compression, and malleability, were most obligingly tested for me by Mr. Anderson at the Royal Gun Factory, Woolwich; and the other qualities by Messrs. Simms, by whom the great Theodolite is now being constructed. I will take the above enumerated properties in their order, premising that to have obtained results of an absolute and final character would have involved more time than I could spare, and that therefore those which follow, though sufficiently reliable for almost any practical

purpose, are open to the correction of more extensive experiments.

"(1) *Tensile strength.* This was tried some years ago by Mr. Anderson with the following results. Breaking strain

Aluminium bronze . . .	95,747	lbs. per square inch.
Gun metal	32,000	

"Mr. Anderson was good enough to try it again for me in September last, and states in his report, 'The average tenacity of this metal proved to be 22 tons 12 cwt. (50,624 lbs.) breaking weight per square inch in the two specimens tested; elongations did not take place until 4300 lbs. in the one case, and 3600 lbs. in the other, had been applied, when a permanent elongation was noticed of ·009 of an inch in the first specimen, and ·034 of an inch in the last.' Mr. Anderson adds that the specimens were not quite sound.

"In the above cited report Mr. Anderson gives a higher tensile strength to gun metal than before, namely, 17 tons (38,080 lbs.) for the average of the '*best specimens*' tested at the gun-factories.

"Combining the results we have the average breaking tensile strength of the two metals as follows:—

Aluminium bronze	$\frac{95747 + 50624}{2} = 73,185$	lbs. per square inch.
Gun-metal	$\frac{32000 + 38080}{2} = 35,040$	

the ratio being 1 to 0·48, or rather more than 2 to 1 in favour of aluminium bronze.

"For the purpose of comparing the tenacity of the new alloy with steel, we have data given by Mr. Anderson in a lecture* on Materials for Rifled Cannon, in which he states that cast steel varies in tensile strength from 114,000 to 67,000 lbs. per square inch; but he objects to the higher qualities as liable to brittleness, and prefers, where great strains are in question, an average quality of cast steel breaking at 80,000 lbs.; and he adds, that specimens from a gun made of Krupp's famous cast steel, characterised by 'softness' (which Mr. Anderson considers favourable to tenacity) and 'perfect soundness,' gave 72,000 lbs. per square inch, which we see is 1185 lbs. less than the average strength of aluminium bronze above given.

"(2) *Resistance to Compression.* Mr. Anderson reports on this as follows:—

"'The ultimate amount of compression applied was 59 tons, 2 cwt. 1 qr. 4 lbs. (132,416 lbs.), under which the specimen†

* Published in No. XXIII. *Journal*, Royal United Service Institution.

† "The specimen subjected to this enormous pressure, distorted though it is, does not exhibit the trace of a fissure. The cohesion of its particles is inviolate."

became too much distorted to permit of more weight being applied with any true result. Compression was not perceptible until 9 tons, 2 cwt. per square inch (20,384 lbs.) was applied, when the specimen suddenly gave to the extent of ·006 of an inch, and on the weight being removed an elasticity of ·001 was observed, which gives the first permanent compression as ·005 of an inch.'

"The compressive strength of cast iron varies a good deal. That of 'Carron Iron, No. 3,' the highest given in Ure's *Dictionary of the Arts*, is 115,542 lbs. per square inch; but it is difficult to compare in this respect two metals whose behaviour under compression is so different, cast iron yielding suddenly and almost totally, and the new alloy more gradually and partially. Astronomical instruments, however, are more dependent on the rigidity or resistance to a transverse force than to any other quality.

"(3) *Malleability.* Mr. Anderson states on this head:—

"'The qualities of this metal for forging purposes would appear to be excellent; with the exception of the part heated to a red heat in the shade, all show that it is a good workable material under the hammer almost up to melting point.'

"I may add that there were specimens in the Exhibition, showing that the alloy could be drawn out under the hammer almost to a needle point.

"I come now to the experiments tried by Messrs. Simms.

"(4) *Transverse strength.* As the absolute determination of the force necessary to break or permanently bend a bar of metal was beyond our appliances, I begged Messrs. Simms to be satisfied with a comparative value of the rigidity of the new alloy; that is, to ascertain the relative resistances of gun metal, brass, and aluminium bronze, to a force insufficient to produce permanent flexure. This they succeeded in doing, and report as follows:—

"'The same weight applied to three bars altered the index of our instrument as under,

Brass	2·22 divisions
Gun metal	0·15 ,,
Aluminium bronze	0·05 ,,

"Hence, aluminium bronze would appear to be 3 times more rigid than gun metal, and upwards of 44 times more rigid than brass.

"(5) *Expansive ratio.* This determination was also a comparative one. Messrs. Simms found that 'aluminium bronze is less affected by change of temperature than either gun metal or brass, (a little less than gun metal, and much less than brass).'

"(6) *Founding qualities.* Regarding this there is ample experience. The alloy produces admirable castings of any size.

"(7) *Behaviour under files, cutting tools, &c.* In this respect, also, it leaves nothing to be desired. It does not clog the file; and in the lathe and planing machine the tool removes long elastic shavings, leaving a fine bright, smooth surface. Messrs. Simms state,—

"'It can be worked with much less difficulty than steel, and we should think that screws made of it would (notwithstanding the original great cost of the metal) prove in the end less expensive than screws made of steel.'

"(8) *Resistance to atmospheric influences.* Messrs. Simms state, 'it does not readily tarnish.' This, likewise, is entirely a relative question. Absolute inoxidizability, however desirable, is hardly to be expected. Suffice it, that the new alloy tarnishes much less readily than any metal usually employed for astronomical instruments, viz., gun metal, brass, silver, cast-iron, or steel.

"(9) *Fitness to receive graduation.* Messrs. Simms state, 'Aluminium bronze takes a fine division, and it will not be necessary to inlay another metal, as is usually done, to receive the graduation.' This opinion is fully justified by the specimen of graduation executed by Messrs. Simms, the lines of which are remarkably pure and equable, characteristics never presented, in the same degree, they inform me, by lines cut on any other *cast* metal. May not this superiority indicate that the alloy in question is peculiarly homogeneous? The lines are very distinct under the microscope, notwithstanding the yellow colour of the metal.

"(10) *Elasticity.* I possess no direct experiments bearing on this point. But that the alloy has considerable elasticity is unquestionable. I may here state that an eminent Parisian Instrument-maker informed me that of all the wires tried for the suspension of Foucault's Pendulum for illustrating the rotation of the earth, none, not even those of steel, were so durable under that severe ordeal as wires made of aluminium bronze. It would appear, therefore, to be the most proper material for the suspension springs of clock pendulums.

"(11) *Fitness for being made into tubes.* It admits of every process necessary for this purpose. It can be soldered with either silver or brass solder; it can be rolled into sheet metal; and it can be hammered and drawn. Hitherto telescope tubes, the cones of transit axes, the pillars of altazimuths, &c., have been made almost exclusively of yellow brass, a metal very deficient in rigidity. Gun metal does not admit of being rolled, and has therefore never been used for the tubular parts of instruments, for which the new alloy seems pre-eminently suitable.

"(12) *Specific gravity.* The specific gravities of alloys of aluminium and copper, as determined by Messrs. Bell, are

3	per cent.	of aluminium	8·691
4	,,	,, ...	8·621
5	,,	,, ...	8·369
10	,,	,, ...	7·689

The last named, which is the best for the purposes now under notice, is very nearly the same as that of wrought iron, and less than that of either brass or gun metal.

"It appears from these experiments, and from the concurrent testimony of those who have given it a fair trial, that the 10 per cent Aluminium Bronze is far superior, not in one or some, but in every respect, to any metal hitherto used for the construction of Philosophical Apparatus, and that for such purposes it may be employed in the dimensions that would be proper in the case of cast steel. All parts which otherwise would be made of steel may, with perfect safety, and even with advantage, be made of the new alloy, particularly such parts as bolts, and fixing, tangent, and micrometer screws. Its hardness and comparative inoxidizability point it out as peculiarly adapted for pivots, axes, and bearings. If employed for receiving the graduation of circles, the necessity for inlaying another metal will be obviated, by which two advantages will be gained; the hammering which forms part of the operation of inlaying, and which, more or less, must cause unequal density and tension in the circle subjected to such treatment, will be dispensed with; and the effect of inequality of expansion in the circle and the inlaid strip will no longer be a cause of apprehension. With respect to the due visibility of divisions cut on this metal, opinions will perhaps differ. I can only say that I should be well content to observe with them.

"The use of this alloy for the construction of the new Great Theodolite is, in the opinion of Messrs. Simms, and in my own, fully justified by what we now know of it; and the effect of using it will be to keep the weight of the instrument within reasonable limits, notwithstanding its possession of means and appliances not hitherto bestowed on such instruments.

"Two points remain; the making of the alloy, and its cost.

"The metal Aluminium is at present extracted in England by one firm only, Messrs. Bell Brothers, Newcastle, under a license from M. Deville, the French discoverer of the process. I have met with instances of failure in making the alloy with Copper. Two main points only, however, seem to require particular attention. First, extremely pure copper must be used. The best is copper deposited by electricity, but that kind is very expensive; the next best is copper from Lake Superior, which makes an alloy of excellent quality. The ordinary coppers of commerce generally fail, owing, it is said,

chiefly to the presence of iron, which appears to be specially prejudicial. The second precaution is to re-melt the alloy two or three times. The first melting of 10 aluminium and 90 copper produces an alloy of excessive brittleness. Each successive melting, up to a certain point determined by the working, and particularly the forging, properties of the metal, improves its tenacity and strength. It is probable that after several meltings there will remain in combination with the copper a somewhat smaller proportion of aluminium than 10 per cent.

"The present price of the English made 10 per cent. Aluminium Bronze is 6*s.* 6*d.* per lb., but there is reason to believe that, as the process of extracting the aluminium becomes more largely practised, and the demand for the metal increases, the price will fall. The above price is four or five times that of gun metal. A much smaller quantity, however, of the new alloy than of gun metal will give the same strength; and when it is considered how small a ratio the cost of the material bears to the cost of workmanship in refined apparatus, it will be found that even at the present price of the new alloy its cost is not prohibitory, whilst the advantages attending its use promise to outweigh the increased expenditure.

"In the foregoing paper, which I am aware is very imperfect and incomplete, I have sought no more than to contribute such an instalment of practical information regarding this remarkable material as may be of service to those, who, like myself, contemplate making use of it, of whom I trust there will be many, for by its use we shall, I venture to think, confer on such structures at once greater strength and less weight, and so diminish tension, flexure, and distortion, to an extent calculated sensibly to improve the higher order of instruments of physical research.

On the Solar Energy as manifested in the Autumn of 1861 *and a Portion of the Spring of* 1862. By W. R. Birt, Esq.

During the summer of 1860, both previous to and in connexion with the great outburst of solar energy, that occurred towards the end of June in that year, I noticed a very marked monthly maximum and minimum of solar spots; and while there existed indications of an intermittent action of the solar force, I was satisfied that the maxima and minima I had frequently noticed were dependent on the rotation of the Sun.

Regarding each group of spots, single spots, if unattended by smaller ones, or separate nuclei if they were sufficiently distinct to warrant the appellation, as centres of energy, I laid

down from time to time curves of which the centres of energy were the ordinates.

Taking the solar meridian turned directly towards the Earth at noon of the 9th of July, 1861, equal to 270°, and employing the period of $27^d\ 7^h\ 10^m$ as that of the synodical rotation of the Sun, I set off 27 abscissa, each being distinguished by a Roman numeral I. to XXVII. preceded by the zero; and as the rotation of the Sun apparently carries a meridian about 13°·19 westwardly per diem, each ordinate may represent any solar meridian within the limits of 13°·19; thus the zero may represent any meridian between 353°·41 and 6°·59, and XIV. any one between 178°·02 and 191°·20, and so on.

I have the pleasure of submitting to the Society the curves of five synodical rotations from observations in August, September, and October, 1861, and April and May 1862.* Each presents a well-marked maximum, and the indications of minima are also apparent. The maxima are, without exception, acuminated, showing in each case not so much a diminution of energy as a removal from observation of the active solar surface by rotation.

The most instructive feature of the curves consists of the portions of the surface of the solar globe indicated as manifesting the greatest energy. 1861, August, the meridians 23° to 208° manifested the greatest energy during the period; indeed, a much greater activity than the opposite hemisphere. During the next rotation the energy was greatly subdued; the curve, nevertheless, exhibited *an increase* of force between 125° and 297°; and by projecting the September under the August curve, the similarity of features, as regards the increase and diminution of activity, is unmistakeable.

The October curve, after presenting us with a solar hemisphere perfectly quiescent, meridian 42° gives us increased action from 108° to 293°; indeed, there had been an increase of activity since 42° was central. Collecting these areas of increased energy, we have a portion of the solar surface extending over 274°, manifesting considerably more energy than the remaining portion of 86°. The following are the meridians of maxima:—August, 156°; September, 138°; October, 200°; and this extent of 62°, or thereabouts, may be regarded as the locality of greatest energy for those months, as referred to heliographic longitudes. The heliographic latitudes of solar energy are well known.

1862 the April curve exhibits subdued energy from meridians 14° to 173°, then increased energy to 332°, with a maximum at 292°. The May curve manifests during its earlier portion more activity than the April, with a minimum

* The drawings of these curves were exhibited at the Meeting in June last.—Ed.

at 156°. This was the meridian of maximum in August, so that the activity on the hemisphere, of which 156° is the central meridian, is now greatly reduced: in fact, the direction of the curve is reversed. From this meridian the curve manifests increased energy. The two curves for April and May presents as perfect an agreement in their features as those of August, September, and October, 1861. At the present time the hemisphere of greatest energy is marked by the central meridian 300°, or thereabout.

On a remarkable Chain of Lunar Craters forming a portion of the Southern Boundary of the Mare Serenitatis. By W. R. Birt, Esq.

The chain of Craters I am about to describe is but very seldom seen. I have only obtained three good views of it during the last eighteen months, viz., in 1861, April 16; 1862, May 5 and October 29. It is situated on the southern border of the Mare Serenitatis, between the conspicuous Crater Menelaus and a promontory running into the apparently open space forming the common boundary of the Maria Tranquillitatis and Serenitatis. This promontory is known as the Promontorium Acherusia.

The interest attaching to this chain of Craters will depend most probably on its having been overlooked both by Schröter, and Beer and Mädler. Although the Craters are small (they are larger than those in the neighbourhood of Eratosthenes) and situated on a narrow wall of rock running between the Maria Tranquillitatis and Serenitatis (if it be not situated on the surface of the Mare Tranquillitatis), the wall of rock rising nearly perpendicularly from level surfaces on the north and south of it, yet the locality is sufficiently remarkable, combined with the rarity of catching a sight of the Craters, to render it important to place a notice of their existence on record in the archives of this Society.

I first saw them in the year 1861, on April 16, my observations extending from 8 hours to 9·30, Greenwich Mean Time. The following is a quotation from my Journal of that date:—

"The Mare Serenitatis is separated from the Mare Tranquillitatis by a well-defined steppe, the Serenitatis being at the lower level.* From the Apennines, past Menelaus, to a point opposite Plinius, the border of the Mare Serenitatis is rugged, the highest portion of the wall from Menelaus to the terminating point consisting of a chain of small Craters—they are on the surface of the Mare Tranquillitatis, and appear at this epoch exceedingly interesting from their proximity to each other, the

* This steppe is admirably shown on one of Mr. De La Rue's photographs.

black shadows contrasting with the highly illuminated opposite rims. From the most western of these Craters, to Webb's Mount Argæus, the surface is very smooth, but the line of demarcation between the Maria Tranquillitatis and Serenitatis is well seen, and is exceedingly well defined towards its eastern extremity, near the small Craters. It is almost lost in the neighbourhood of Mount Argæus . . . . These Craters are exceedingly interesting, projecting, as they do, *alone* without any accompanying *ruggedness* into the smooth surface of the Mare Tranquillitatis."

On the 5th of May, 1862, I had an opportunity of minutely inspecting these Craters, and described in my Journal the wall in which they occur, from the Promontorium Acherusia to about one-third of the distance from the promontory to the bright Crater Menelaus, when the terminator skirted the eastern edge of the Mare Serenitatis. A quotation from my Journal will be the best description I can give:

"About two-thirds of the wall S.S.W. of the Mare Serenitatis, from the Promontorium Acherusia to the bright Crater Menelaus, is formed of small Craters interspersed with brighter portions hardly of the nature of peaks. The termination of the promontory is a bold, jutting, but low rock; it is succeeded by three deep Craters, hardly distinguishable from each other; they are quite in shadow. Two rocks and another Crater, which is isolated, form the further continuation of the wall. None of these Craters are given by Beer and Mädler. They are succeeded by a somewhat low portion of the wall to near the locality of the Crater B, of Beer and Mädler, where a jutting rock is seen. Adjoining and abutting on the Crater B, is another small, deep Crater, making the fifth from the termination of the promontory. The Crater B is nearly double the size of the small one on the border north of it, and it has a mountain on the south-west. Schröter has delineated it as being very much larger than Taquet, he marked it *g*. At a very little distance from the small Crater on the border, and separated from it by a low rock, are two more small Craters of the same character; they form the base of an isosceles triangle, Taquet being the apex. Another mass of rock intervenes, and we have the eighth Crater from the promontory. These Craters are pretty nearly of the same size, and differ but slightly from Taquet in this respect. The last two are the only Craters of the eight given by Beer and Mädler.

"In Beer and Mädler's map Taquet is given as larger than B. B is fully double the size of Taquet, and A on the south of the high land on which B is situated, and also on the border of the Mare Tranquillitatis, is about the same size as B. A is indicated as the largest on the map."

Schröter marks A (*e*), it is a little larger than Taquet in his delineation.

In connexion with these differences from Beer and Mädler's map, another Crater on the border of the Mare Serenitatis may be specified; it was observed the same evening, and is not indicated on the map. The record of it is as follows:—

"The depression *b*, Beer and Mädler, south-west of Menelaus, is finely marked; there is a Crater nearly north of it *on the wall*, it is larger than either of the previous eight, and is not in Beer and Mädler's map. This Crater is found in Schröter's figures marked *m*, also the shallow depression figured as a *deep* Crater marked *f*, the second instance of this kind which I have met with."

On the 29th of October I have the following notice: "The Craters on the ridge terminated by the Promontorium Acherusia very apparent, the terminating point *bright*."

The almost extreme difficulty of seeing these Craters, as they are visible but for a short time after sunrise—I have not seen them under the evening illumination—will, I apprehend, fully account for their having been omitted by the Selenographers above named. On a suspicion crossing the mind of the darker portions of the south wall of the Mare Serenitatis being the *shadows of cliffs*, I made the following note under date of May 5, 1862:

"The regularity appears to be too great to countenance this idea, the interior illumination is perceptible in that abutting on B of Beer and Mädler, also in the eighth, which is given both by Schröter, and Beer and Mädler, nor do the shadows fall quite in the direction for giving them the character of shadows of cliffs."

Some other communications received prior to the November Meeting, will be published in the next number of the *Monthly Notices*.—Ed.

Minor Planet (78) *Clytia.*

The Planet was discovered by Mr. Tuttle, at Harvard College, on April 7 (see *Ast. Nach.* Nos. 1368, 1370, 1374). Elements have been computed by Mr. Hall and Mr. Safford; those of Mr. Safford, from observations of April 7, 18, 25, and May 8 and 26, are

Epoch 1862, May $2^d\ 0^h$, Washington M.T.

L	=	184° 30′ 53″·6	Mean Equinox 1860·0
Π	=	61 11 13·5	
Ω	=	7 32 23·7	
i	=	2 24 49·6	
φ	=	2 31 14·4	
μ	=	13 35·029	
$\log a$	=	0·425889.	

Minor Planet (74) *Galatea.*

The discovery of this new Minor Planet by M. Tempel at Marseilles is announced, *Ast. Nach.* No. 1381, where the following positions are given:—

	h m	h m s	° ′ ″
Aug. 29	10	0 2 32	+3 55 —
30	10 30	0 2 12	+3 50 30

the planet being of the 11th magnitude. The following are the elements computed by Dr. Frischauf from observations of Sept. 16, 22, and 28.

Epoch, 1862, Sept. 16·0, Berlin M.T.

		° ′ ″	
M	=	353 48 52·9	Mean Equinox 1363·0
Π	=	6 42 36·5	
☊	=	200 29 20·2	
i	=	3 15 43·8	
φ	=	14 12 26·3	
μ	=	858″·5920	
Log a	=	0·410813	

Minor Planet (41) *Daphne* ((75)?).

It appears (*Ast. Nach.* Nos. 1380 and 1382) that, at the Bilk Observatory, on the night of Aug. 31st, at about $11\frac{1}{2}^h$, Dr. Luther observed a planet of the 11th magnitude resembling the lost planet *Daphne;* and that, from this observation and two observations of Sept. 5 and Sept. 11, at Berlin, the following elements have been computed:—

Epoch, 1862, Sept. 5·5, Berlin M.T.

		° ′ ″	
M	=	88 51 17·5	Apparent Equinox at Epoch.
Π	=	233 44 39·8	
☊	=	179 7 7·7	
i	=	14 38 49·4	
φ	=	16 47 27·7	
μ	=	728″·320	
Log a	=	0·458452	

which agree so nearly with Dr. Seeling's elements of *Daphne* as to leave no doubt of the identity of the two planets. The planet is however in subsequent numbers referred to as *Daphne* (75).

The name "*Melete*" instead of *Pseudo-Daphne*, given to the minor planet (56), has not hitherto been mentioned in the *Monthly Notices.*

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